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Industry Power

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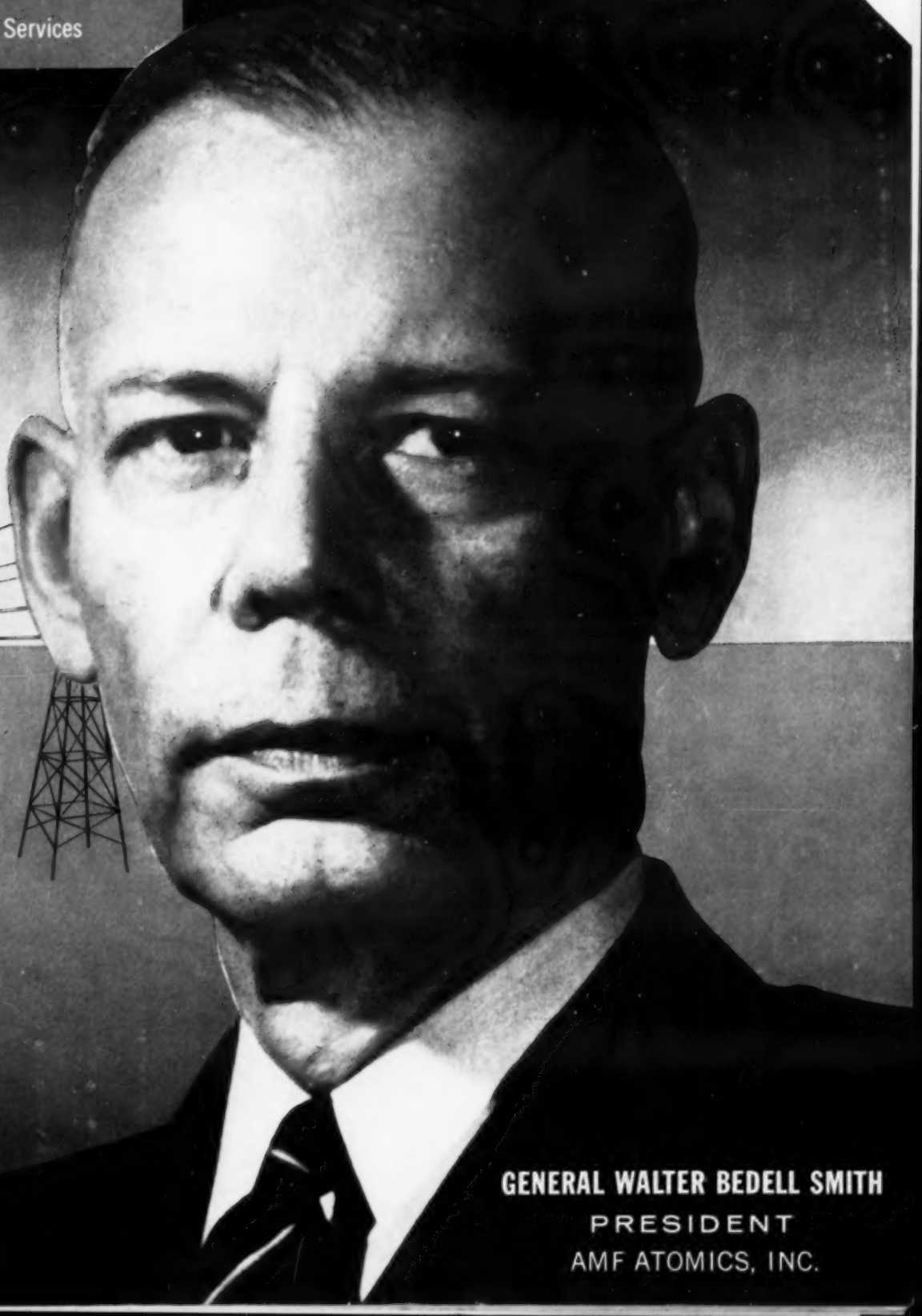
APRIL 1957

For Men Who Manage

Power Services

How Eli Lilly Solves
WATER POLLUTION
SEE PAGE 14

THE FUTURE OF INDUSTRIAL NUCLEAR POWER



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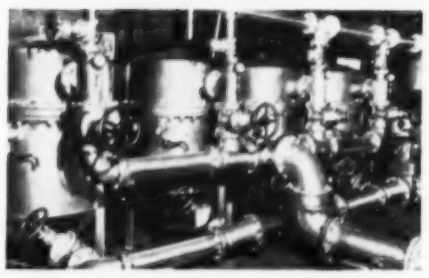

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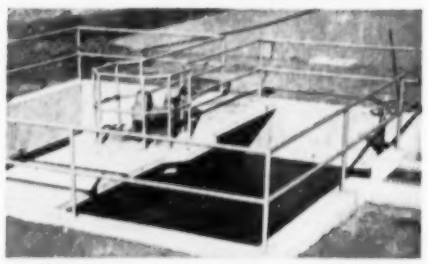

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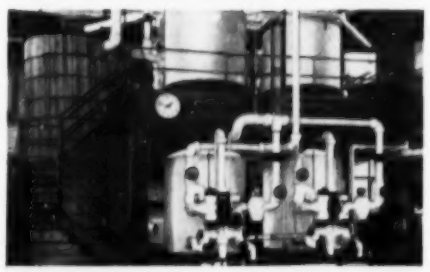

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that's interesting

. . . for industry power

Failures are foreseen

A signalling system that provides an alarm and record of the malfunction of any component in demineralizing equipment assumes that sooner or later a component failure will occur in any automatic control system. The controller, developed by Infilco, Inc., also provides for automatic shutdown of the programmed operation, if desired. Location of the function failure is immediately indicated, alarmed, and recorded by the controller—thus locating the failure quickly and making speedy correction possible.

Is there an inventor in the house?

Ideas of free lance inventors are needed right away to help solve nine problems baffling the armed services, according to the National Inventors Council, U. S. Department of Commerce. Nine revolutionary ideas needed are: a portable non-magnetic compass; a method for locating explosives buried at shallow depths below the ground (present detectors locate the container or hole); an invention to convert a small amount of light into enough electricity to operate electric equipment; a practical means of destroying tell-tale snow tracks of men or vehicles; equipment of useable size that will produce death rays effective at 500 yards without excessive power input; a new traction method for land vehicles for use on all types of terrain, including paved roads; a new means of quickly discharging large quantities of military supplies from commercial or military ships; inventions to mask the light, noise, and radiation from combat vehicles operating at night; and a new method of transmitting intelligence, non-detectable except by the desired receiver (this must not use electric impulses, electromagnetic waves, or sound waves). Solutions should be mailed to the Council in Washington 25, D. C.

New fuel source probed at U. C.

Algae may be harnessed to provide man with a new source of fuel. Researchers at Sanitary Engineering Laboratory at the University of California have obtained small quantities of methane gas by controlling a series of natural processes involving the growth and decay of algae. Experiments were conducted in a closed system using artificial light and highly concentrated pond algae. In nature, algae cells convert and store the sun's energy by photosynthesis. Algae release this energy as methane or other gases when they die and are attacked by various bacteria. Laboratory experiments control these same processes in a small closed system of tubes and detention reservoirs.

Reclaim your old rare metals

Castor Engineering Company has established a new metal reclamation service for companies who work with electronic components. Germanium, platinum, gold, molybdenum, nickel, and copper may be recovered from processing scrap and from components including diodes, transistors, or crushed tubes. Firm will evaluate any two-pound sample to determine whether or not the new recovery process will show the customer a substantial dollar advantage over present scrap sales. Charges are based on salvage value. ♦ ♦

Industry Power

FORUM

The future of industrial nuclear power

GENERAL WALTER BEDELL SMITH, President
AMF Atomics, Inc.
with H. A. Bergen, Editor

OUTSTANDING INHERENT CHARACTERISTIC of a nuclear power plant is its independence of geographic limitation when compared to fossil-fuel-fired or hydro plants. That is, cost of transporting nuclear fuel is such a small fraction of total cost as to be negligible — at almost any location. Coal, oil, and gas transportation costs are usually an appreciable, or major, fraction of these fuels' costs. Hydro power is dependent upon falling water and, therefore, is restricted to specific locations. If electric energy is transmitted long distances, transmission cost is a considerable factor in the user's power cost.

Thus, if a medium-size nuclear power plant (20,000 to 40,000 kw, electric) becomes available at a reasonable price and on a standard commercial guaranteed basis, power-using industry will be freed from "location" limitation. We can assume that power will be available at all locations at essentially the same price.

First industries to take advantage of this factor undoubtedly will be those that are presently operating in high-fuel-cost areas. This, however, appears to be only the beginning. There are areas in the world that have many natural resources waiting to be exploited — but which have not been touched because of lack of power. Thus, nuclear power, in the long run, can be expected to permit exploiting undeveloped areas, dispersing industry, and, perhaps, change the pattern of our industrial civilization considerably.

To be effective, nuclear power plants must be economically available in sizes required by industry. This appears to be largely in the 10,000- to 100,000-kw range — with relatively few industries requiring the larger sizes. Large plants — several hundred thousand kw and up — will be useful only to utilities serving large load centers. Of course, these large nuclear power plants must generally compete with the cheap existing fuels or hydro which originally justified the load center.

These large utility-size plants must produce power for about 7 mills/kwh or less to justify themselves. On the other hand, a 10,000- or 20,000-kw plant established at an industry site in the desert or mountains or some other isolated, high-cost area may be economically justified with power costs of 15 mills/kwh or more. Power from fossil fuels hauled to the area, or power transmitted to the area, would cost more.

Thus, it is our belief that there will be considerable utility and demand for the medium-size nuclear power plant for industrial purposes. It is also quite apparent that these medium-size plants will be competitive and economic even with power costs considerably above those of large central utility stations. We believe, also, that exploitation of undeveloped areas and freeing of industry from geographic limitations can be done only with medium-size plants. All of these beliefs are supported by economic evaluations of a wide range of industrial requirements that we have made during the last year.

It is one thing to establish the requirements for industrial nuclear power plants . . . and another to supply them. Normal industrial users cannot afford to experiment in their power plants. They must purchase well-tested, guaranteed equipment at an established price with known operating costs. Constructing and operating power reactors has not yet reached the stage where it is possible to give the potential customer all of the assurances he normally requires. For one thing, no supplier can point to years of successful operating experience with a power reactor of his own design and construction. Total nuclear fuel costs, including the reprocessing cycle costs as well as maintenance costs, cannot be determined from experience. And some of the necessary services yet remain a government monopoly.

For these reasons, practically all power reactor construction is now being financed by the government as part of its development program, or by combinations of large companies, or by both.

First application of an industrial nuclear power plant must have a high load factor — to overcome the higher first cost and fixed charges of the plant — and must be located in an area with higher present fuel costs than the expected nuclear fuel costs.

There are many locations in the world where these conditions exist now. Here are two actual examples from foreign countries:

CASE 1. A paper mill operating at base load 345 days per year, requiring both process steam and

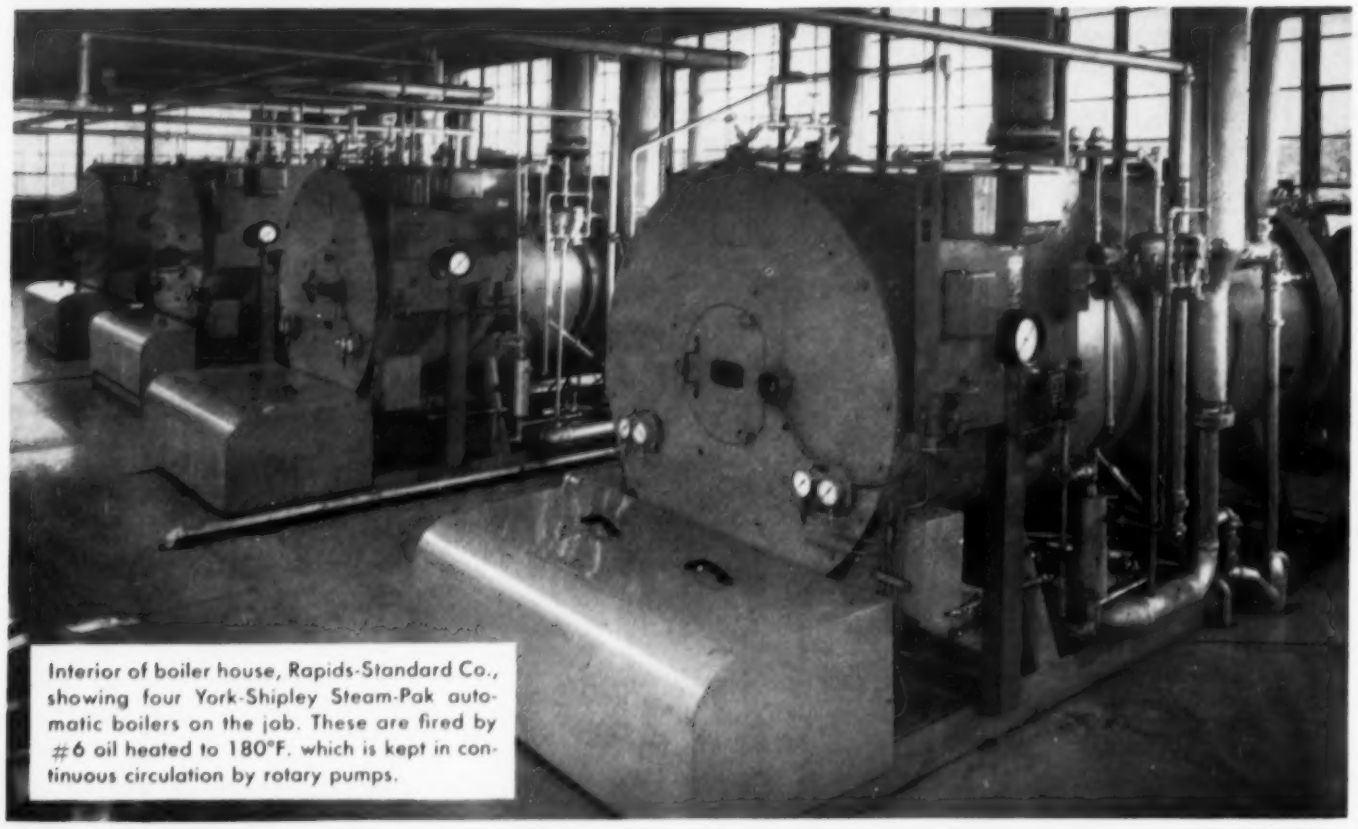
(continues on page 8)

About General Smith

General Walter Bedell Smith (retired) is chairman and president of AMF Atomics, Inc., atomic energy subsidiary of American Machine & Foundry Company. He is also vice president of the board of directors of American Machine & Foundry Company.

General Smith served as Chief of Staff under General Eisenhower in Europe during World War II, and also as U.S. ambassador to Russia and director of the U.S. Central Intelligence Agency.

His other current activities include his posts as president of Industrial Laboratories Reactor, Inc., a nuclear research center to be operated at Plainsboro, N. J. by 10 of this country's most prominent companies; and chairman and president of AMF Atomics Canada Limited.



Interior of boiler house, Rapids-Standard Co., showing four York-Shipley Steam-Pak automatic boilers on the job. These are fired by #6 oil heated to 180°F. which is kept in continuous circulation by rotary pumps.

They're saving money today . . . and looking after tomorrow, too!

How York-Power Steam-Paks more than doubled heating output . . . with no increase in building costs.

For more than eight years, two YORK-POWER Steam-Paks had been supplying ample heat for the Rapids-Standard Company in their Plymouth, Michigan plant.

The efficiency and economy records of these boilers were so high that when the time came to double plant facilities, company engineers realized they could do no better than to add two more Steam-Paks to take care of increased heating needs.

"From our particular view point," said Mr. Russell A. Inwood, Vice President of Engineering and Manufacturing, "the flexibility which YORK-POWER Steam-Paks provided for continuous expansion was of greatest importance. Also, because there were no expensive chimneys or foundations to construct, and because the units were pre-wired and pre-piped, we could cut down on installation costs."

SAVED BUILDING COSTS. Merely by rearranging the floor plan of the over-size boiler house, it was found that two more Steam-Paks could be set up . . . with *no extra building costs.* These four units now take care of all present heating needs and also provide for continued expansion for many years to come.

Find out how YORK-POWER Steam-Paks can help you. Our engineers are available to give full cooperation. Specification sheets and detailed data are yours for the asking. Write TODAY.

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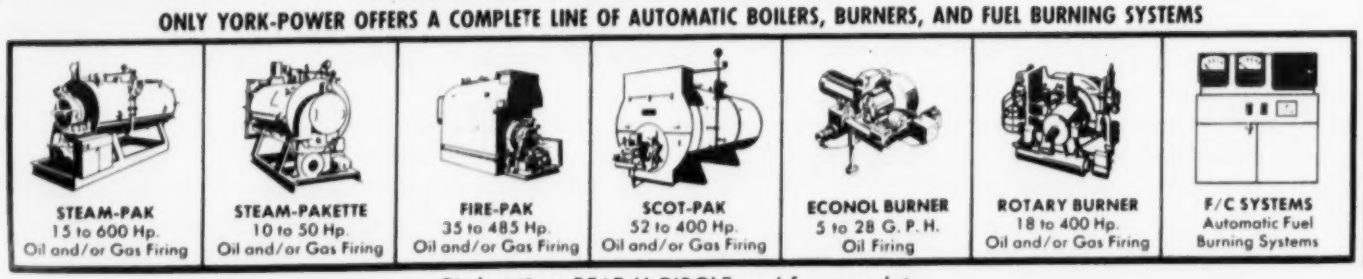

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Industry Power

FOR MEN WHO MANAGE POWER SERVICES

VOLUME 72 NO. 4 APRIL 1957

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seventeen climates under one roof 12

Processing, office, and laboratory areas at the new Ditto Inc. plant are divided into 30 zones to provide individual air supply for comfort and improved production. Only standard components were used for this tailormade job.

make pure water from strong wastes 14

Eli Lilly treats biological wastes 2000 times stronger than ordinary sewage and discharges an effluent that is up to 30 times purer than the river into which it goes. Only plant flexibility makes this possible.

how big a motor? 16

When selecting a driving motor for a centrifugal pump, you evaluate not only horsepower needs but also duty cycle, acceleration, and regulation. You can use this article as a guide when you next face the problem.

basic steam plant design 18

If you need a boiler with 7000 to 31,500 lb/hr capacity, you can save money by using these basic designs, worked out by the Navy's Bureau of Yards and Docks to cut down on their costs for shoreside installations.

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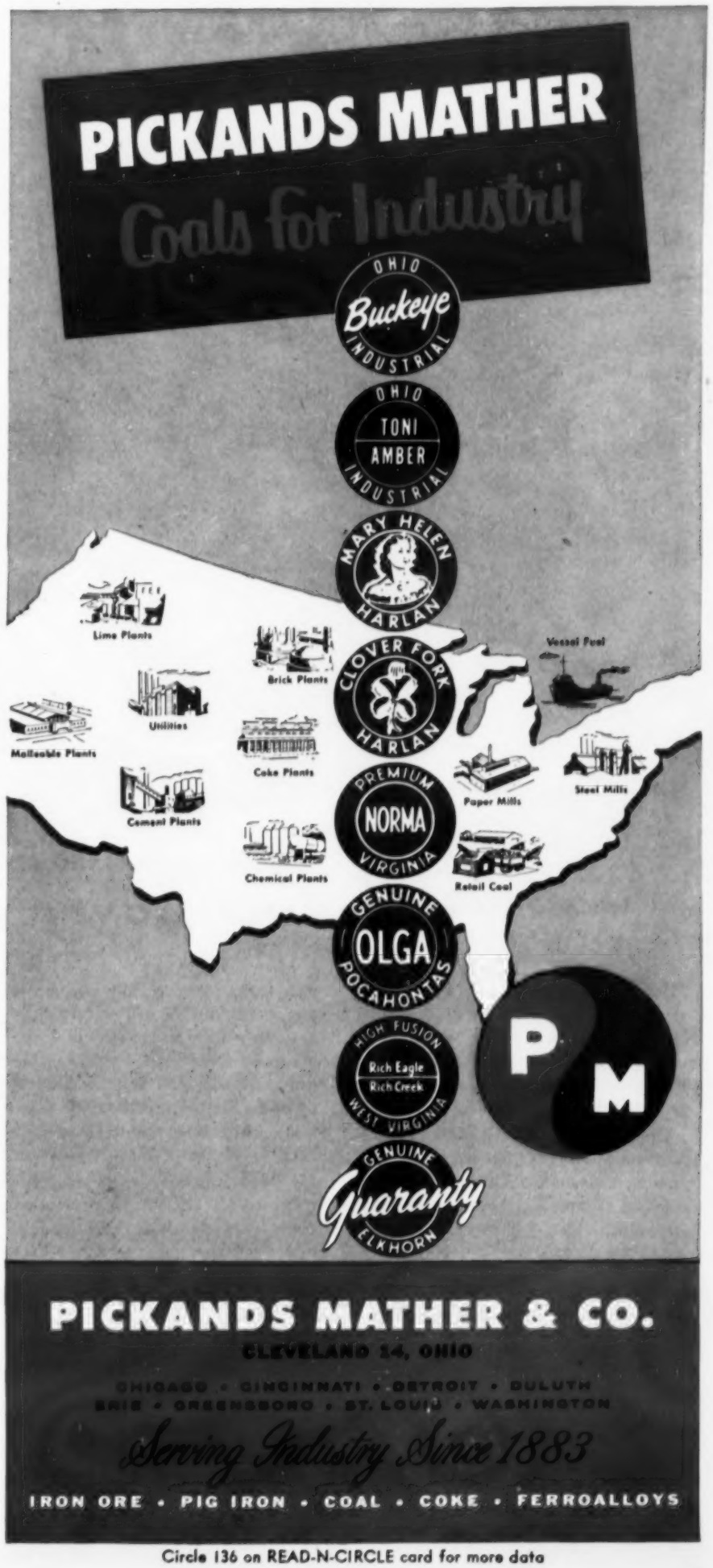

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Unretouched photo showing typical return line corrosive action resulting from carbonic acid and dissolved oxygen in condensate.

BREAKING DOWN WITHIN

This section of pipe looks like new—on the outside. But take a look inside. Grooving action caused by carbonic acid and deep pitting, the result of dissolved oxygen attack, have almost completely penetrated the pipe wall.

Dearborn FILMEEN* prevents such destruction. FILMEEN forms a protective, non-wettable barrier between treated steam, or condensate, and metal pipe surfaces. By preventing the carbonic acid and dissolved oxygen from coming into contact with the metal, FILMEEN assures corrosion-free lines. FILMEEN is only one of many Dearborn water conditioning products scientifically developed to control specific corrosion problems. Others eliminate scale, sludge, carry-over and similar difficulties.

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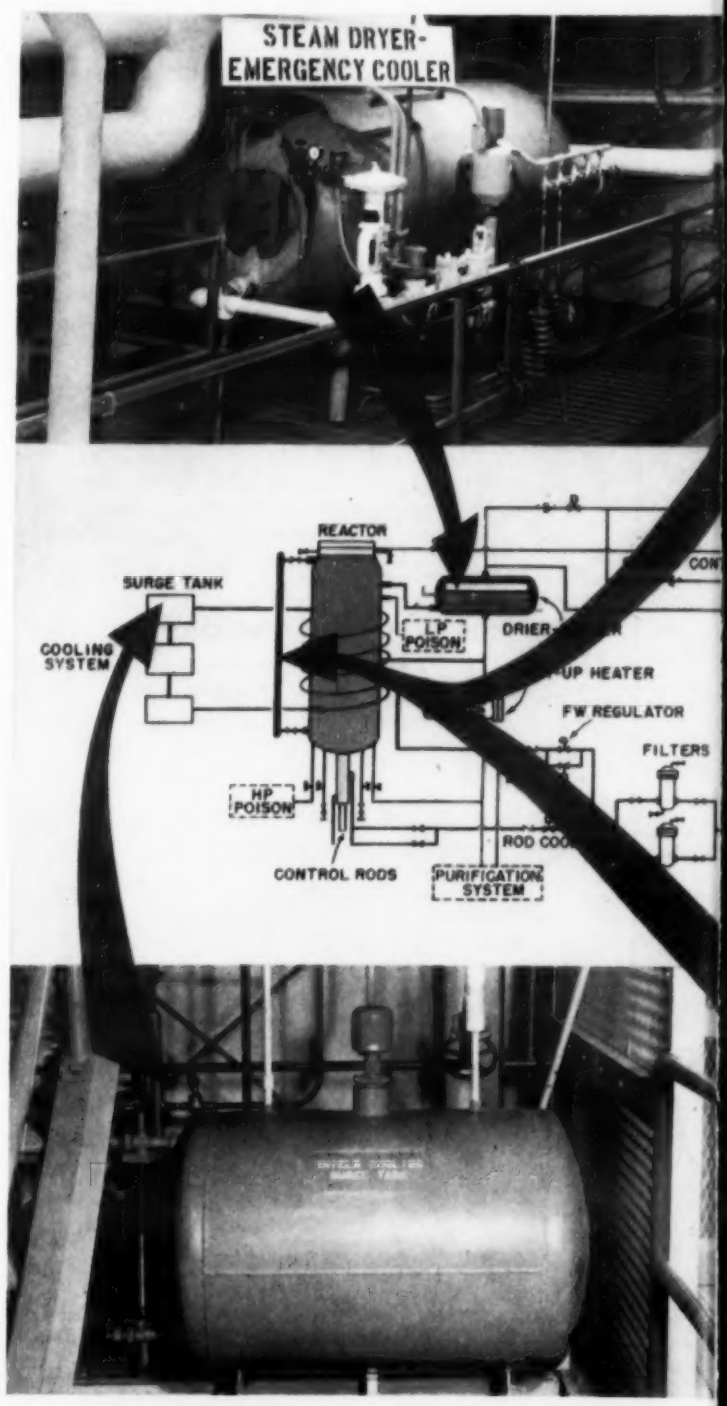
nuclear news

. . . about industry power

SAFETY PRECAUTIONS FOR ARGONNE EBWR

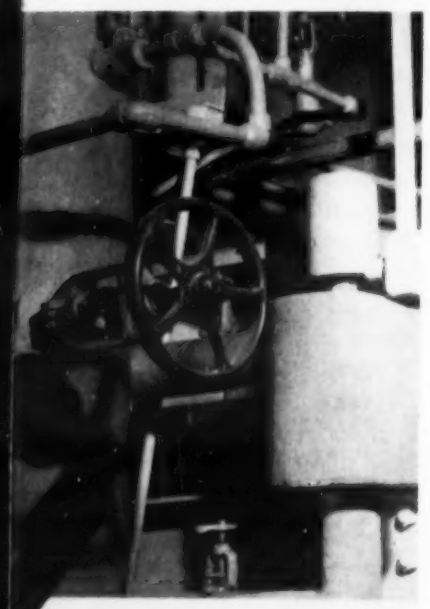
When the Experimental Boiling Water Reactor Plant at Argonne National Laboratory went into operation last month, much was said about the nuclear reactor's operation. But little has been said about the engineering that has gone into the safety of this operation.

The EBWR is similar to a conventional power plant — it is powered by a water-

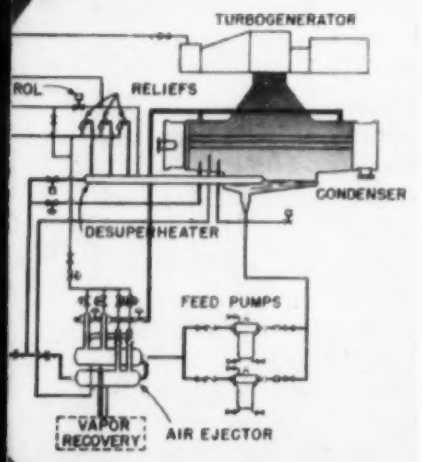


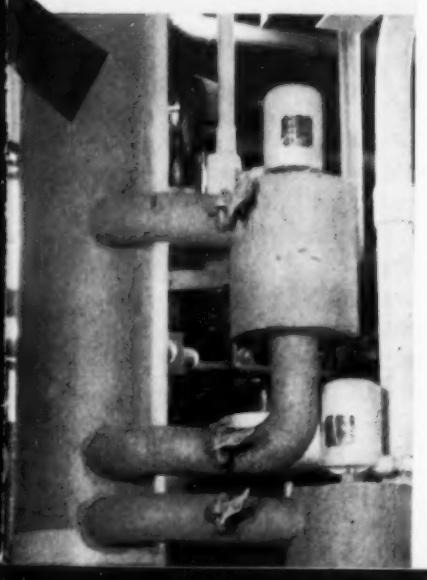
moderated and water-cooled uranium reactor core that provides 20,000 kw of heat. Fuel is uranium with a low U^{235} percentage. Saturated steam at 600 psig passes through a turbogenerator with an output of 5000 kw.

Since the reactor is flooded, steam produced is quite wet, so it is passed through a steam drier with an emergency cooler. A flow switch signals an alarm when this cooler is in operation. The cooler tank is fitted with a high-level alarm.



The reactor water column has a high-level alarm and two low-level alarms. If water level drops below the upper of these two low-level alarms, a system that injects boric acid is automatically started. This immediately floods the reactor to dampen nuclear fission. Level alarms warn the control room that the system is in operation. If the level in the water column continues on downward after this upper low-level alarm has sounded, the lower low-level alarm signals final shutdown and sounds an evacuation alarm. Similarly, if level in the reactor water column reaches the high level, the evacuation alarm will sound.



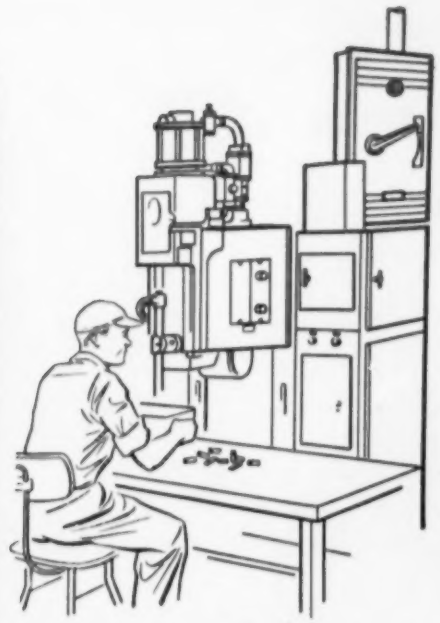


Altogether, 16 Magnetrol level controls are in use on this nuclear reactor and its auxiliaries at Argonne. They are mostly conventional types, as used in all industry, with some custom made in special metals. ♦ ♦

I-T-E

MOLDED CASE CIRCUIT BREAKERS

Magnetic only type ETI circuit breakers are available in F, J, K, KL, L and M frames (3 to 800 amperes continuous ratings), 2 or 3 pole, 600 v a-c, 250 v d-c.



Typical resistance welder application of *magnetic only* type ETI circuit breakers in an individual enclosure.

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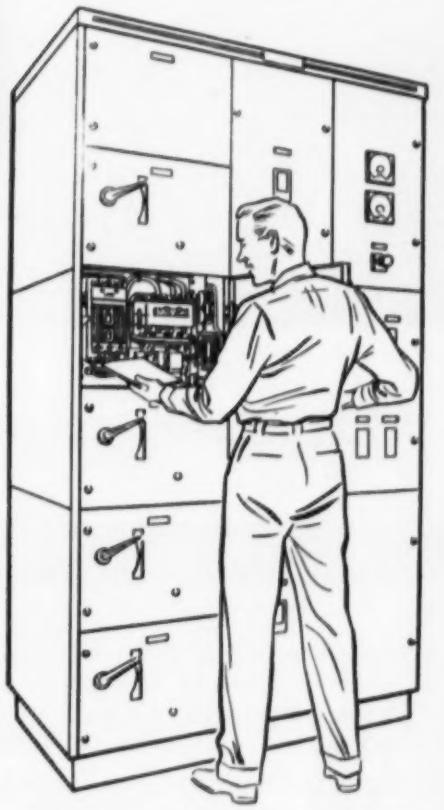
External instantaneous trip adjustment.

In motor control and resistance welding applications, adjustment of protective devices to a required setting is important. One of the many features of the ETI circuit breaker is its convenient externally adjustable magnetic trip device. When it is required to adjust the trip to a finer degree, adjustment is made from the front of the breaker without interrupting service or encountering live conductors. The range of instantaneous trip adjustment means greater protection for motors and resistance welders. When a short circuit occurs, all poles open simultaneously. And enclosed terminals protect personnel, yet permit easy cable connections. All these extra values in I-T-E Molded Case Circuit Breakers are yours at no extra cost. Send for complete information or contact your nearest I-T-E authorized distributor.



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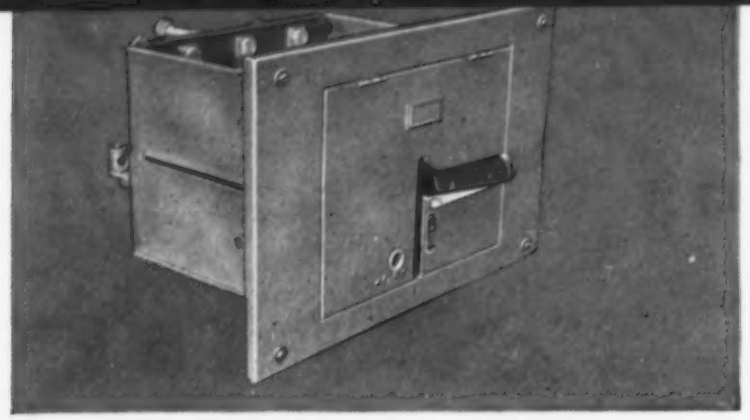

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Nuclear power

. . . starts on page 3

power, burning coal fuel. Plant size is 60,000 kw, heat. Present delivered fuel cost is $25 per ton or $1.00/million BTU. CASE 2. A mining operation operating 24 hours per day, 350 days per year, with 100-mile, high-tension transmission line between power plant and mine. Power plant burns fuel oil. Plant size is 20,000 kw, electric. Present delivered fuel cost is $0.75/million BTU.

These two actual operating plants could greatly improve their economy by installing nuclear power plants. In the first case, the fuel cost saving alone (even with wide variations from the basic nuclear fuel cost estimate) will justify the installation. In the second case, the plant investment (when the transmission line, its costs, and losses are included) is smaller for a nuclear plant at the mine than a conventional plant 100 miles away. Thus, there is reduction in fuel costs and fixed charges.

These two examples from foreign countries are obvious examples of present economically sound locations for medium-size nuclear power plants. There are many of them throughout the world. They are perhaps not so numerous in the United States but do exist in some locations. As nuclear power plant investment costs reduce through experience and as operating and fuel costs reduce and stabilize — and as fossil fuel and hydro become shorter in supply — it is highly probable that there will be a continuing and increasing demand for medium-size nuclear power plants. As these plants become available on a normal commercial guaranteed basis, exploiting undeveloped locations, previously mentioned, may begin. This should further increase the demand.

There are many obstacles yet to be overcome. In addition to the technical ones which have been mentioned, there are others . . . such as those inherent in government regulations, the establishment of commercial fuel processing operations, and insurance. Progress is being made on all these fronts. We believe the problems will be solved. We believe there is a sound future in the business of supplying industrial nuclear reactors. ♦ ♦

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IF IT'S NEW . . . IF IT'S DIFFERENT . . . IF IT'S BETTER . . . IT'S

BULLDOG

ELECTRIC PRODUCTS COMPANY

A DIVISION OF I-T-E CIRCUIT BREAKER COMPANY

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late news

. . . about industry power

• U. S. will participate

Plans for U. S. participation in the 17th biennial session of the International Conference on Large Electric Systems, to be held in Paris, France, June 4 to 14, 1958 have been launched by the U. S. National Committee. As one of 41 nations participating in activities of this organization, the U. S. has the opportunity of presenting up to eight technical papers at the meeting. Papers must deal with achievements in the field of high-voltage power generation and transmission in this country. Invitations are being sent to U. S. advisors on some 18 technical committees asking for recommendations for subjects of broad U. S. and foreign scope and interest. Selection will be made under the chairmanship of C. W. Franklin, electrical engineer, Consolidated Edison Co.

• Sootblowers regulate steam temperature

Broad range steam temperature regulation is the job of sootblowers on Units 1 and 2 at Cromby Station, Philadelphia Electric Co. Vernier control is then handled by gas recirculation, biasing superheater and reheater dampers, and by spray desuperheaters on Unit 1; and by tilting burners, desuperheater sprays, and by biasing the firing rate to the superheat or reheat furnaces on Unit 2. Both boilers are designed so that all walls are formed by tangent tubes, which eliminates refractory surfaces, but introduces large steaming areas that must be kept free of slag. This cleaning is done by Vulcan automatic wall deslaggers. Remaining surfaces, superheaters, reheaters, air heaters, and so on, are cleaned by Vulcan long retractable sootblowers with travel extensions from 18 to 28 feet.

• Ground-water problem does not exist

There is no national ground-water problem as such, but there are numerous widely scattered problem areas, according to Mr. Albert G. Fiedler, assistant chief, Ground Water Supply Branch, Water Resources Division, U. S. Geological Survey. He goes on to say, "Despite some pessimistic predictions that we will not be able to meet the large prospective demand for water, the situation is not, as a whole, dark. We are one of the best watered nations in the world . . . . the solution is generally a matter of economical rather than physical feasibility, and the necessary economic adjustments will be made wherever failure to make them would result in a still greater cost to the community and the nation." ♦♦

BETZ LABORATORIES

W. H. & L. D. BETZ
Chemical Engineers
REGISTERED PROFESSIONAL CHEMICAL ENGINEERS
CONSULTANTS ON ALL WATER PROBLEMS
GENERAL OFFICES AND LABORATORIES
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is now

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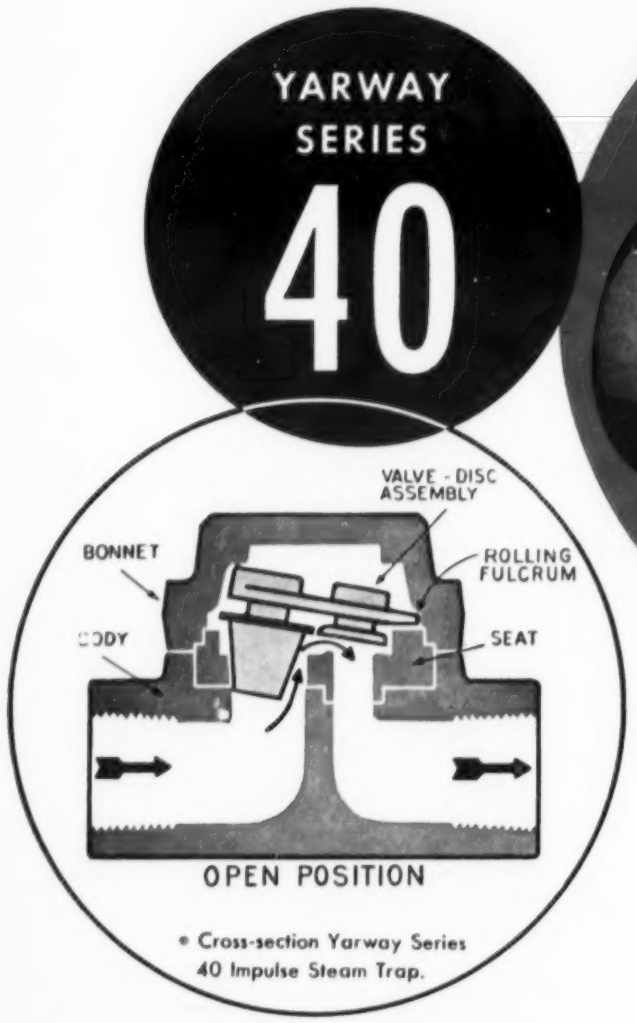
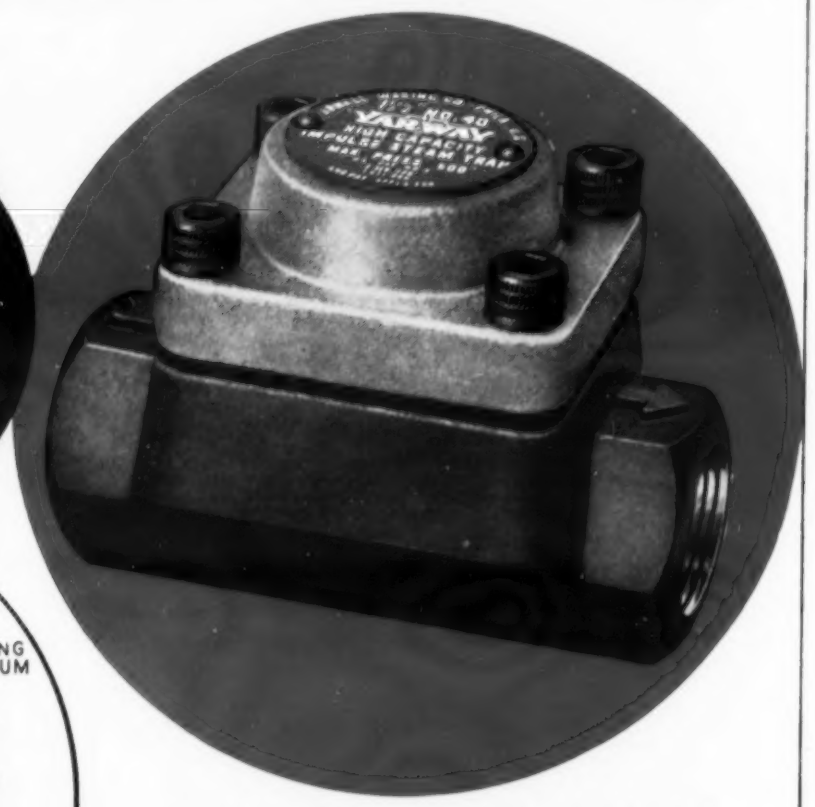
GENERAL OFFICES | ENGINEERING HEADQUARTERS
GILLINGHAM & WORTH STREETS, PHILADELPHIA 24, PA.
CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

This YARWAY IMPULSE STEAM TRAP is for extra heavy condensate loads



• Cross-section Yarway Series 40 Impulse Steam Trap.



The famous Yarway "impulse" principle of thermodynamics that revolutionized steam trapping many years ago, is now applied to a steam trap for extra heavy condensate loads—the Series 40 Impulse Steam Trap. Users report with this trap they obtain quicker heating, higher and more even temperatures in their process equipment.

It also incorporates all the other advantages of earlier Impulse trap designs, such as—immediate response to load changes, no air binding, light weight and small size. Maintenance is low, thanks to stainless steel body and working parts.

High condensate capacity of Yarway Series 40 Impulse Steam Traps makes them ideal for heavy condensate loads on large autoclaves, cooking kettles, dryers, heat exchangers, heating coils, presses, unit heaters, etc.

Suitable for all pressures up to 600 lbs. maximum, without change or adjustment. Operates against back pressures up to 50%. Five sizes, ½", ¾", 1½", 2" and 2½".

Your Yarway man will furnish a Yarway "40" for 90-day free trial in your plant without obligation, or write for Yarway Bulletin T-1746.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.

STANDARD SERIES 60
YARWAY IMPULSE TRAP

For normal steam trap applications the standard Series 60 Yarway Impulse Steam Trap is recommended. For *extra light* condensate loads use the Yarway 20-A Impulse Steam Trap.

Both are described in Yarway Bulletin T-1739X.

YARWAY® IMPULSE® STEAM TRAP

OVER 1,000,000 YARWAY IMPULSE STEAM TRAPS USED

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Industry Power

Shepard-Benning Building, Saint Joseph, Michigan
Telephone: YUkon 3-5515

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- Advertisers' nearest sales and service offices are indexed alphabetically. See pages 53 and 54.
- Advertisements are indexed by products in handy guide. See page 46.
- Important literature is indexed by products. See page 33.

this month's comment . . . .

the accelerating pace of nuclear power . . .

WHAT ARE THE PROBABILITIES that readers of this magazine will be directly concerned with nuclear power in the near future?

Frankly, new developments make us revise our opinions every day as to when the application of nuclear power will be widespread in U. S. industry.

In September 1955, we published an article by Dr. Karl P. Cohen titled "Are You Thinking yet About Nuclear Power for Your Plant?". His predictions of how rapidly nuclear power would develop were challenged by many, but it now looks as though some of his predictions may have been too conservative.

Any shortage, or even threatened shortage, of fuel supply (such as the Middle East situation) is another stimulant to the development of nuclear power facilities. Such a stimulant, unfortunately, can cause inflated speculation about the need for nuclear power to avoid power shortages. The realities of fossil fuel supply and availability in this country guarantee adequate power at a lower cost than nuclear power for some time to come.

In keeping our fingers on the pulse of these developments, as this is written, two of our editors are attending the 2nd Annual Nuclear Congress, coordinated by the Engineers Joint Council. Their reports will assist you to determine how fast you must accelerate your own learning about nuclear power.

So that you will have the information to speed up your acquiring this knowledge, we have planned another of our Power Basics series—these will give you the basics of nuclear power. An early issue of INDUSTRY POWER will announce the series.

Also available shortly will be excerpts from the program of the American Power Conference—a substantial portion (and a well-attended one) was devoted to operational aspects of nuclear power.

Another indication of early industrial use of nuclear power is the announcement by International Correspondence Schools that they now offer a correspondence course on nuclear energy.

For a clear and informative statement about nuclear power in the near future, read the statements of Gen. Walter Bedell Smith in the Forum on Page 3 of this issue. Interestingly, both the examples he cites are in foreign countries where the delivered cost of fossil fuel is tremendously high.

We admit that many developments in nuclear power are not yet applicable to your plant. But we do realize that you, our reader, are becoming more and more interested in this growing field. You can be sure that we will keep you posted on future nuclear developments and how they will affect you.

PEABODY'S NEW RIFLED TILE HITS THE MARK . . .

over 30 to 1 range instantaneously; 2% steam pressure variation with complete stability and safety, burning gas

A new, basic concept of gas firing, Peabody's rifled tile maintains ignition under the most adverse conditions with assured safety, even when controls break down or go out of adjustment. Specially designed, this rifled tile develops continuous, low-velocity eddy currents, in the rotating air and fuel mixture, which rapidly ignite and serve as continuous, *positive* pilots. Available on new or old Peabody installations, this tile—applied to Peabody Ring-fired Gas Burners—permits minimum load on gas without regard to wind-box pressure settings and with complete safety and stability. Complete details on request.

PEABODY ENGINEERING CORPORATION

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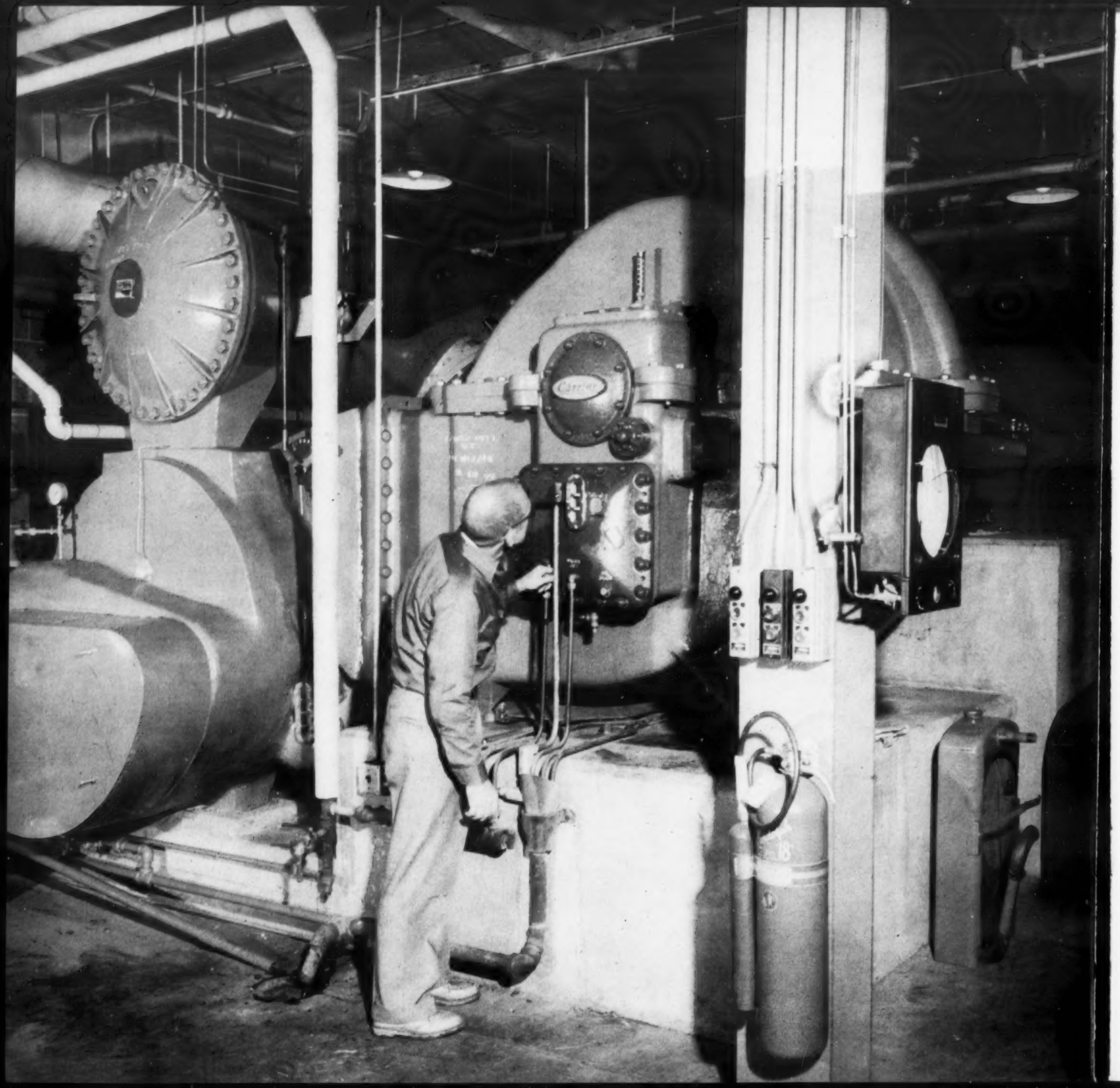


When Ditto, Inc. built their new plant,
they wanted versatility and flexibility.
They used standard components to provide . . .

Seventeen climates under one roof

GEORGE W. KENNEDY, Engineer and Maintenance Manager, Ditto, Inc.
HAROLD C. JANURA, Mechanical Engineer, Battey & Childs
JOHN C. SCOTT, The Powers Regulator Company
with Donald Hartley, Managing Editor

FLEXIBLE AIR-CONDITIONING control system allows 17 different atmospheric conditions to exist simultaneously in the new Lincolnwood, Ill. plant of Ditto, Inc. Different combinations of heating, cooling, and reheating coils, matched with various pneumatic dampers, regulators, valves, and recorders, provide the exact conditioned air needed for each specific area. An outside air temperature control actuates the proper coil. A room or discharge air thermostat then controls the degree of activation in the coils selected. Temperatures may be varied from 90 to 70 F, and relative humidities from 35 to 95%.

More than 600 pneumatic controls, made by the Powers Regulator Company, regulate and coordinate heating and cooling units to provide year-round heating, ventilating, and air conditioning. Entire system was engineered by Battey & Childs, a Chicago architectural-engineering firm, designers of the plant.

Reheat coils, actuated by room thermostats, divide the plant into zones that provide for individual comfort, solar effect, number of people in a room, and temperature of operating equipment. All have reserve capacity.

Two independent systems control conditions in each of the two independent sections in the 312,000 sq ft building. Office area has two stories with 490-000 cu ft, and is entirely air conditioned. Single story factory section has 425,000 cu ft space. Twenty percent of this is air conditioned for process and quality control.

how plant is heated

Fin-type radiators, activated by an outdoor bulb control, satisfy heat loss of all exterior walls in office areas. An indoor thermostat actuates an air-handling heating unit. This establishes a split system of space heating. Projection and horizontal-flow unit heaters are used throughout the factory area. Recirculating-type heaters are used in the center areas, with fresh air-recirculating heaters in perimeter areas. Reheat coils are used in conjunction with cooling equipment in office and factory areas. Total heating load is 19 million Btu/hr. High-temperature forced hot water reduced to 12 psig is used rather than steam to eliminate steam accessory and maintenance problems.

how water is heated

Two 15-million Btu Farrar & Trefts oil-fired, fire tube package hot water boilers burn No. 6 fuel oil with Lammert and Mann burners. Units heat the water to a maximum initial temperature of 230 F at 30 psig. Forced circulation is provided by two 1000-gpm pumps. Water temperature has a permissible drop to 200 F through any unit.

In some plant areas, local circulation of 200 F water is maintained by smaller circulating pumps with 105-gpm capacity at 25-foot head. Each is powered by a 1½-hp electric motor at 1750 rpm. Near each area is a steam-to-water converter. Local systems are valved so that hot water from the main grid can be used, or the water being heated by a converter can be isolated from the main system. Steam for the converters is taken from the process system.

This optional valving provides humidity control through the use of reheat coils in the summer when the main heating boilers are shut down. Another advantage of this usual circulation system is that a minimum base load is established for the process steam boiler.

Process steam is generated by a 4,180,000-Btu oil-fired, Farrar & Trefts package boiler, delivering 4270 lb/hr at 15 psig.

Factory section has all vertical projection unit heaters and some horizontal blow-type heaters designed for an air inlet temperature of 65 F. Outlet temperature can vary from 90 to 110 F, depending on size, speed, and location. All recirculating-type unit heaters are controlled by Powers key-adjustable direct-acting room thermostats that control fan motors to maintain desired room temperature. Mixing dampers on some horizontal blow-type heaters can proportion fresh and recirculated air in any amount from 0 to 100%.

Heating units are equipped with replaceable Farr steel mesh filters and piped with three-way mixing valves. Modulating-type room thermostats proportion the quantities of hot water from the mains and recirculated water to maintain temperature at the desired level.

Adjustable outdoor thermostat, in connection with baseboard radiation in the offices, varies local loop water temperature in a modified proportion to outdoor temperature.

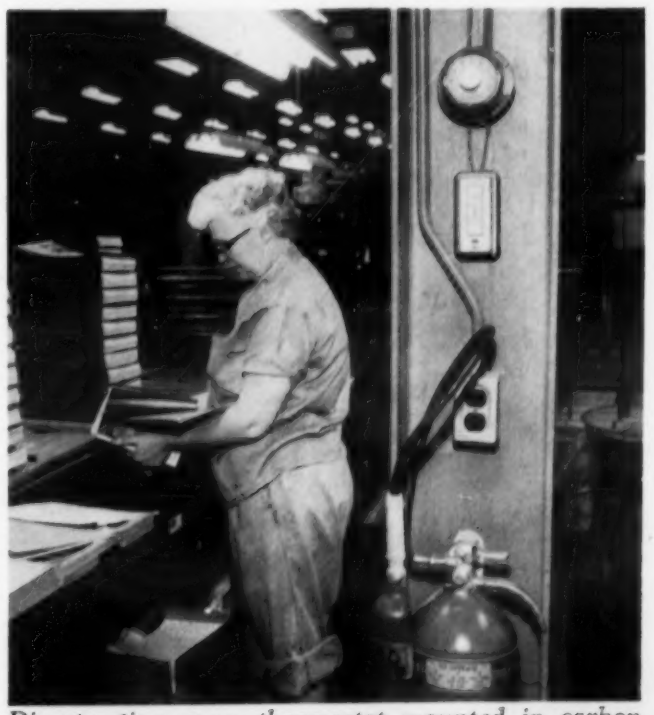
how plant is cooled

An 800-ton capacity centrifugal compressor supplies 45 F chilled water for the cooling system. Cooling load is 96-million Btu/hr.

Office area is divided into two air-conditioning sections, each served by a high-velocity fan moving a total of 29,000-cfm conditioned air.

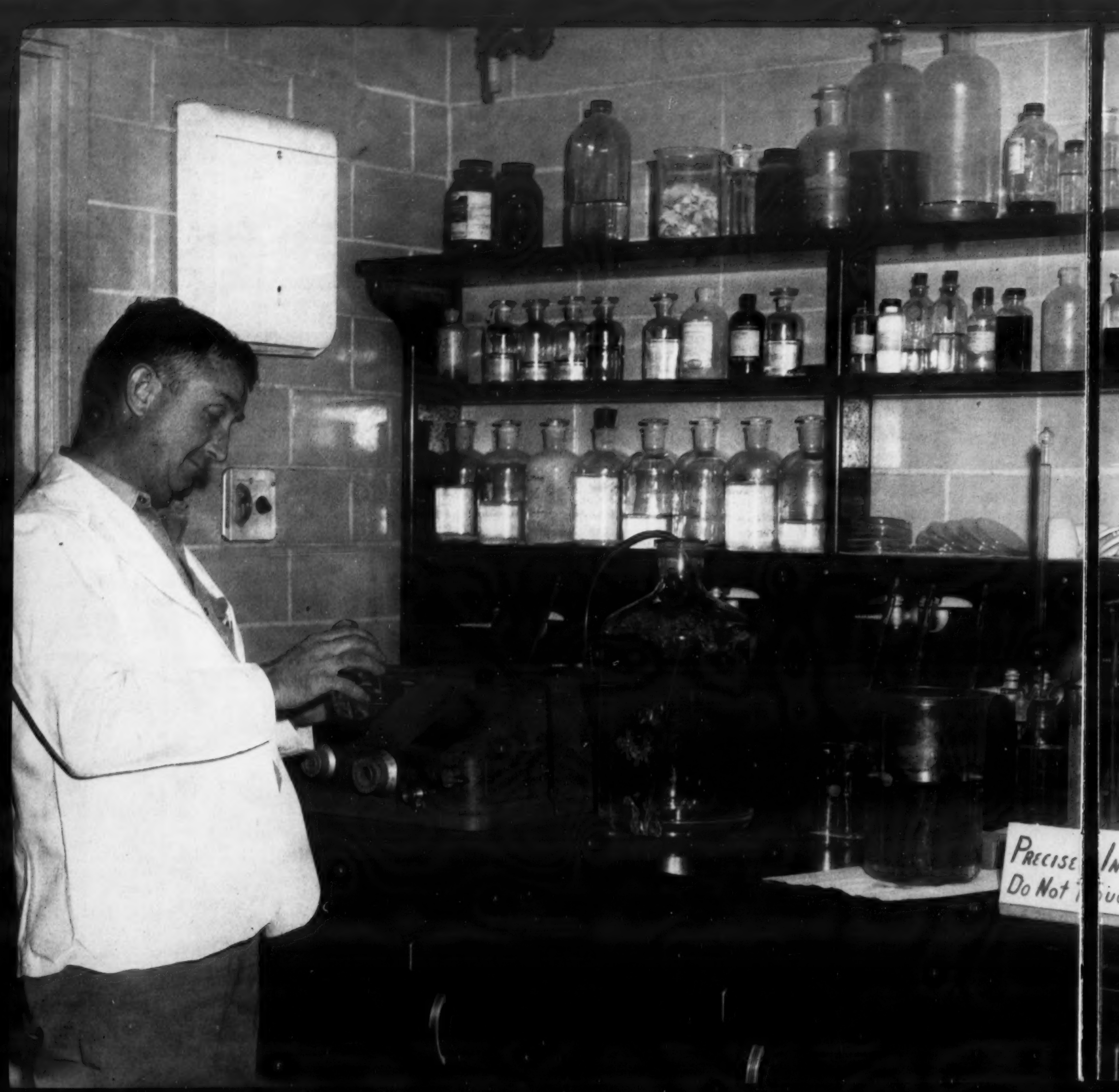
A high-pressure system, operating at 6-in. wg external static pressure, supplies primary air to office areas. Spiral conduit links the fans to strategically located distribution centers. Air is carried from these centers to ceiling outlets through conventional low-pressure duct. Dampers and splitters are used

(continues on page 38)



Direct-acting room thermostat mounted in carbon packaging area starts and stops unit-heater motors.

This 700-hp compressor powers 800-ton, 96-million Btu hr chilled water system to deliver 45 F water.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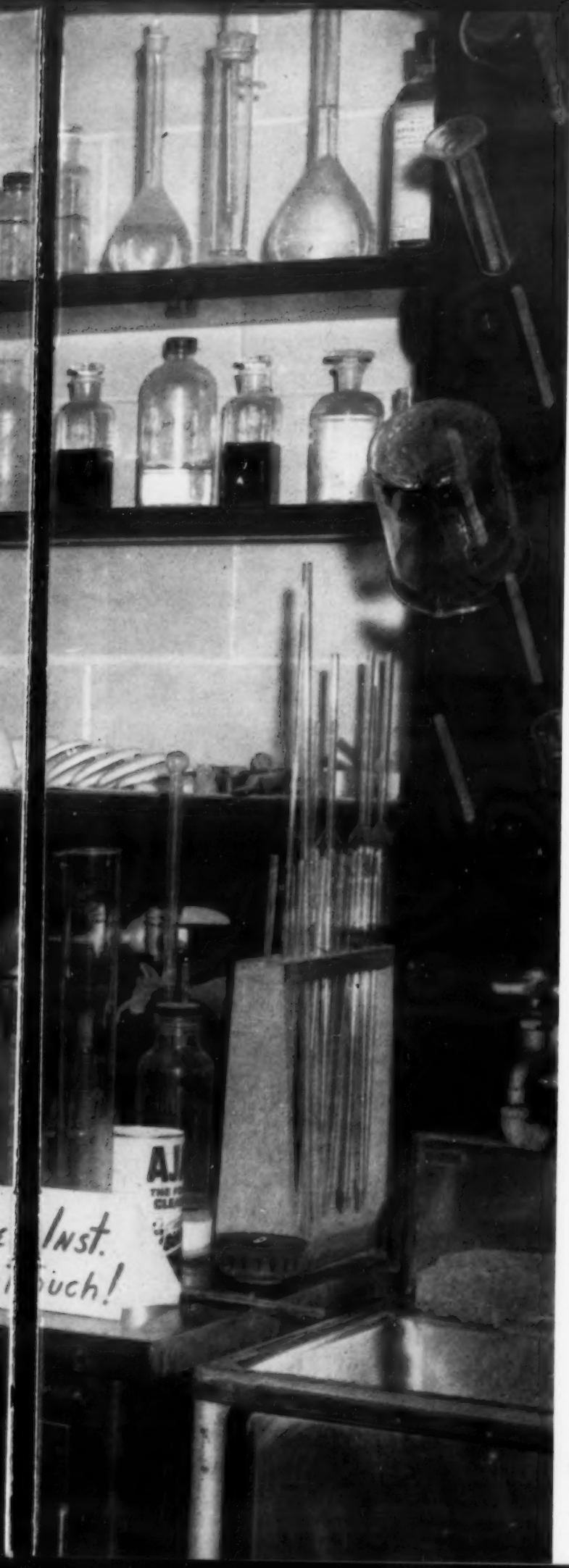


Close control plus recirculation
of antibiotics wastes enables
the Eli Lilly Tippecanoe Laboratories to . . . .

Make pure water from strong wastes

Dr. ROBERT H. L. HOWE
Project Engineer
Eli Lilly and Company
with Robert W. De Moss, Assistant Editor

TAMING STRONG WASTES (2000 times as strong as municipal sewage) and discharging an effluent 20 to 30 times purer than river water is a continuous achievement at Eli Lilly and Company's Tippecanoe Laboratories, Lafayette, Indiana.

Waste treatment and disposal requires major planning and engineering in the construction and operation of a modern pharmaceutical laboratory. With this responsibility in mind, a waste treatment system to handle 1.05 mgd is used. Waste treatment system design engineer is Carl L. Lesher and contractor is the H. K. Ferguson Company, Cleveland, Ohio.

Outstanding problems faced by the waste treatment system of Tippecanoe Laboratories are:

- High B. O. D. loadings
- High solids loadings
- Grease
- Color
- Odor
- Corrosion
- Irregular hydraulic loadings
- Cost of treatment

Waste treatment system was designed primarily to handle antibiotics production waste. Other waste waters include sanitary waste, equipment and floor washings, and laboratory waste discharge. Before actual design was started, an investigation of the hydrological condition and dilution capacity of the receiving stream was conducted. The Wabash River is the receiving stream in the Lafayette area. Possible waste characteristics, then unknown, and flow conditions were also studied. Treatment and disposal of antibiotics wastes, as practiced in other industries, was reviewed and evaluated. A waste treatment system was selected with the approval of the Indiana State Board of Health and the State Stream Pollution Control Board. Construction began in 1952 and system was put into service in April 1954. Total cost of installation was approximately $750,000.

Tippecanoe Laboratory has developed accurate water testing procedures that save operator's time.

treatment follows nine steps

Waste treatment system consists of:

- Neutralization
- Aeration and modified activated sludge process
- Biological filtration
- Clarification
- Anaerobic digestion
- Nitrification
- Chlorination
- Sludge drying
- Dilution

Two general types of wastes, contaminated water and uncontaminated water, are handled by treatment system. Contaminated waste waters include spent

(continues on page 41)

Duty cycle, acceleration, anticipated loads of centrifugal pumps must be considered when you decide . . . .

How big a motor?

T. W. EDWARDS
Manager, Boiler Feed Section
Worthington Corporation
with Robert W. De Moss, Assistant Editor

ARE YOUR DRIVING MOTORS for centrifugal pumps adequate to meet all load conditions that may be imposed? To get maximum safe performance, you must know the torque characteristics of both pump and driver as well as horsepower demands for all anticipated pump load conditions.

Driving motor must handle all anticipated operating loads that may be imposed upon it including startup conditions. Where disconnect clutches are installed, especially in the case of engine-driven equipment, startup may be accomplished with the driver already at full speed and capable of delivering full horsepower.

look at performance curve first

One of the first considerations in determining driver adequacy is the shape of the horsepower vs capacity curve for the pump involved. Shape of this curve not only indicates rated driver power required, but also additional capability that may be required because of abnormal centrifugal pump loading. Shape of the horsepower vs capacity curve is a function of pump specific speed or type classification.

Performance for a low-specific-speed type, (used for low capacity, high-head applications) indicates that zero flow horsepower is 34% to 52% of rated horsepower at best efficiency. With a mixed-flow type (used for moderately high specific speed) zero flow horsepower is 90% of rated horsepower at best efficiency. For a high-specific-speed type, (a vertical propeller-type pump used for flood control work) zero flow horsepower is about 215% of rated horsepower at best efficiency. As these four typical performance curves indicate, sizing the motor solely for a rating point can lead to trouble unless shape of the horsepower vs capacity curve is considered.

We also must consider pump service to properly use pump performance curves. Is this pump going to operate at a constant rated capacity at all times? Or, will it vary widely in capacity because of the particular application? As an example, a boiler feed pump operates to the left of its rated capacity curve under all conditions when serving a boiler alone. When two pumps operating in parallel serve one boiler, however, one pump may carry more than half the rated load under light load operation. This results in operation to the right of its rated point on the curve. Intersection of the head-capacity curve with the system-head curve for one pump operation is beyond the rated point. More than rated horsepower is required. Under such conditions, the driver usually must be selected to meet this maximum horsepower condition.

consider specific gravity of liquid

Specific gravity of the liquid being handled, at pumping temperature, must be considered in sizing the driver. This factor is especially important because specific gravity may vary from 0.50 to 2.0. Failure to account for specific gravity at pumping temperature can result either in wasteful overpowering or failure due to high motor overload.

Secondary driving components are interposed in many cases between primary driver and pump. These include such things as speed-changing gears and variable-speed drives. All secondary driving components introduce some loss because they cannot be 100% efficient. These losses must be added to pump brake horsepower to determine proper drive horsepower.

To attain variable capacity in a centrifugal pump, either discharge flow must be throttled or pump speed must be changed. Some reduction in brake horsepower is *usually* encountered with reduced flows. With speed change, however, pump horsepower demand is *greatly* reduced. This brake horsepower reduction is a third power variation of the speed change at equivalent operating points (Fig. 1). For example, take a centrifugal pump designed to operate at 3550 rpm and produce a 1000-gpm flow against a total head of 200 feet. Pump will consume 63 brake horsepower under these conditions. If we slow the pump down with a variable-speed drive arrangement, its equivalent operating point, at say 2800 rpm, would be 790 gpm against a total head of 124 feet. Pump would consume only 31 brake horsepower at this point (Fig. 1 see page 45).

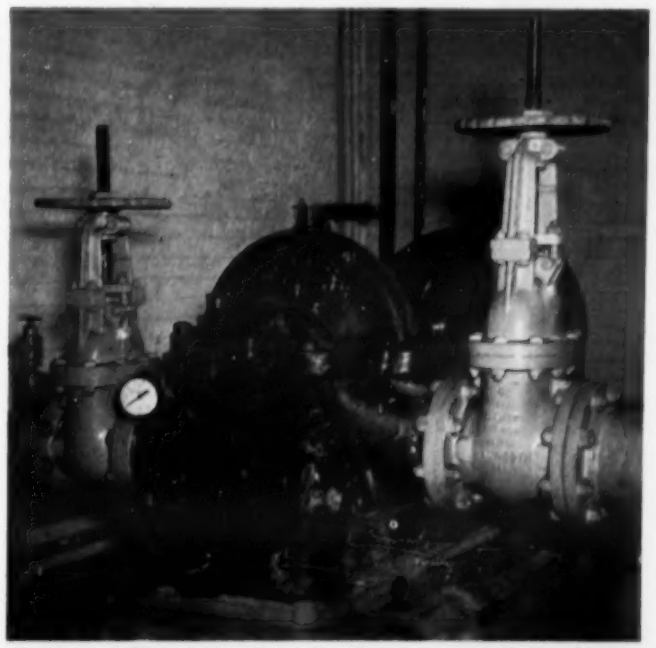
Let us assume, therefore, that a given motor size is selected to drive a centrifugal pump with regard to its specific speed and corresponding shape of horsepower vs capacity curve. We also must consider the pump operating range as well as specific gravity of the liquid pumped and secondary driver losses.

Next requirement is that the direct-connected motor or other driver must start the pump under all possible loading conditions.

speed-torque curve gives results

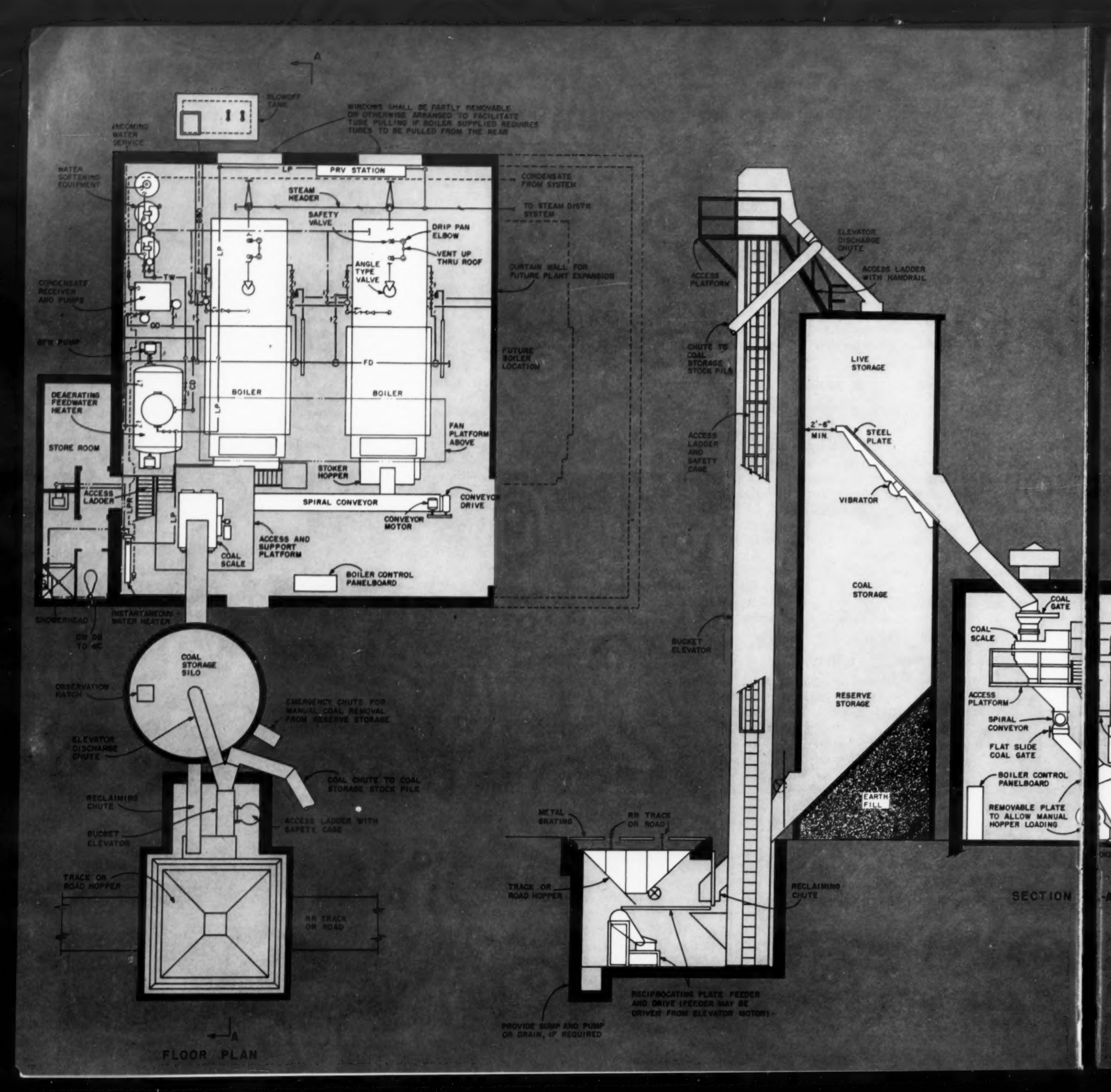
For a moderately low-specific-speed centrifugal pump, line A-B-C is the speed-torque curve for the pump when started against an unpressurized system (Fig. 2). Curve A-B-D shows speed-torque curve for the same pump starting against a closed discharge valve. Curve A-B-E-C shows pump starting against a pressurized system — if another pump were on the line. At point E, check valve lifts and pump being started begins to deliver water into the system. Method of starting, therefore, drastically affects centrifu-

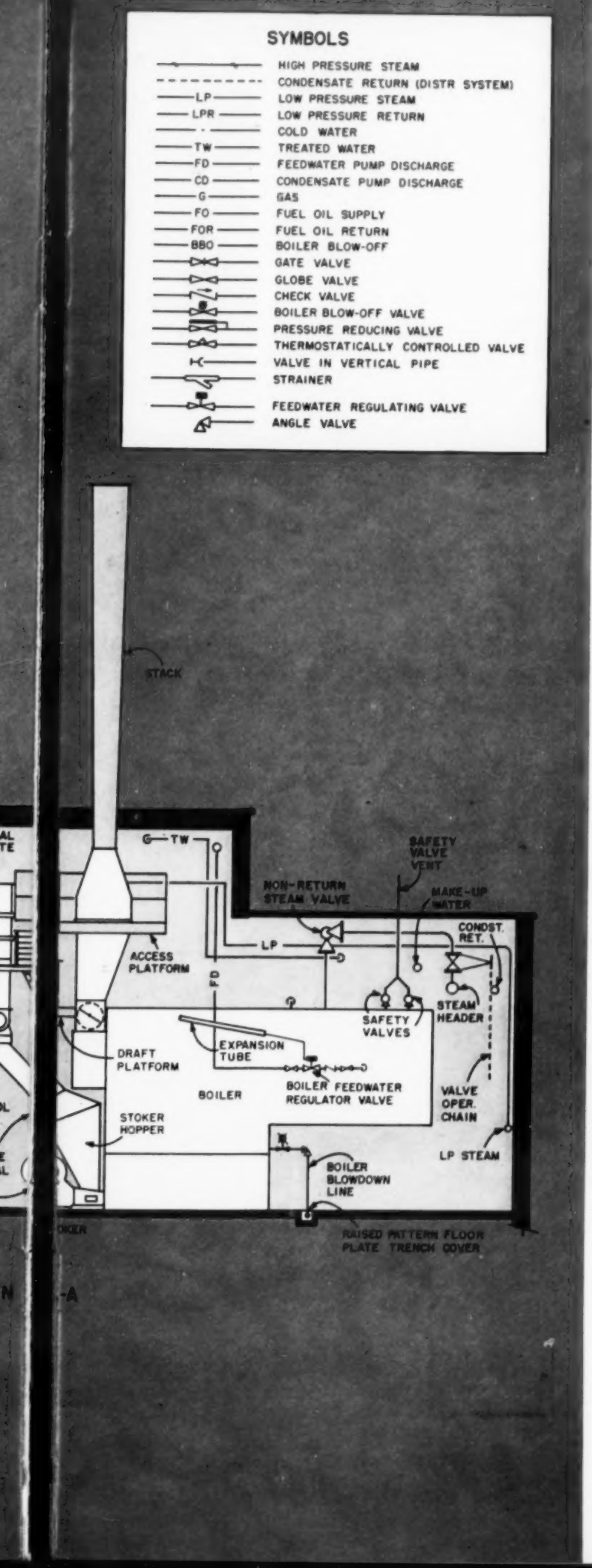
(continues on page 45)



Neat installation with valved suction and discharge gives startup control to prevent overloading motor.

Three 300-hp motor-driven pumps handle 60,000,000 gal/day for Diamond Alkali plant at Pasadena, Texas.


A
BLOWOFF TANK
WINDOWS SHALL BE PARTLY REMOVABLE OR OTHERWISE ARRANGED TO FACILITATE TUBE PULLING IF BOILER SUPPLIED REQUIRES TUBES TO BE PULLED FROM THE REAR
INCOMING WATER SERVICE
WATER SOFTENING EQUIPMENT
LP
PRV STATION
CONDENSATE FROM SYSTEM
STEAM HEADER
TO STEAM DISTR SYSTEM
SAFETY VALVE
DRIP PAN ELBOW
VENT UP THRU ROOF
ANGLE TYPE VALVE
CURTAIN WALL FOR FUTURE PLANT EXPANSION
CONDENSATE RECEIVER AND PUMPS
TW
GD
BFW PUMP
FD
FUTURE BOILER LOCATION
BOILER
BOILER
DEAERATING FEEDWATER HEATER
STORE ROOM
FAN PLATFORM ABOVE
STOKER HOPPER
ACCESS LADDER
SPIRAL CONVEYOR
CONVEYOR DRIVE
CONVEYOR MOTOR
ACCESS AND SUPPORT PLATFORM
COAL SCALE
BOILER CONTROL PANELBOARD
SHOWERHEAD
INSTANTANEOUS WATER HEATER
DW DS TO WC
COAL STORAGE SILO
OBSERVATION HATCH
EMERGENCY CHUTE FOR MANUAL COAL REMOVAL FROM RESERVE STORAGE
ELEVATOR DISCHARGE CHUTE
COAL CHUTE TO COAL STORAGE STOCK PILE
RECLAIMING CHUTE
ACCESS LADDER WITH SAFETY CAGE
BUCKET ELEVATOR
TRACK OR ROAD HOPPER
RR TRACK OR ROAD
A
FLOOR PLAN
ACCESS PLATFORM
ELEVATOR DISCHARGE CHUTE
ACCESS LADDER WITH HANDRAIL
CHUTE TO COAL STORAGE STOCK PILE
ACCESS LADDER AND SAFETY CAGE
LIVE STORAGE
2'-6" MIN.
STEEL PLATE
VIBRATOR
COAL STORAGE
RESERVE STORAGE
EARTH FILL
BUCKET ELEVATOR
COAL GATE
COAL SCALE
ACCESS PLATFORM
SPIRAL CONVEYOR
FLAT SLIDE COAL GATE
BOILER CONTROL PANELBOARD
REMOVABLE PLATE TO ALLOW MANUAL HOPPER LOADING
METAL GRATING
RR TRACK OR ROAD
TRACK OR ROAD HOPPER
RECLAIMING CHUTE
RECIPROCATING PLATE FEEDER AND DRIVE (FEEDER MAY BE DRIVEN FROM ELEVATOR MOTOR)
PROVIDE SUMP AND PUMP OR DRAIN, IF REQUIRED
SECTION



You can save time and money,
if you need a boiler plant with 7000 to 31,500 lb/hr capacity,
by using U.S. Navy, Bureau of Yards and Docks

Basic steam plant design

JOHN W. BISHOP
Mechanical Engineer
Power Generating Section
U. S. Navy Department, Bureau of Yards and Docks
with Donald Hartley, Managing Editor

WHICH BOILER PLANT DESIGN is the most economical to both own and operate? Certain more-or-less standard designs have been developed by the U. S. Navy, Bureau of Yards and Docks that represent (for average conditions) those plants with the lowest over-all annual operating cost plus fixed charges on initial investment for the steam service required.

The two plant outline designs described here are based upon these designs. They serve as a guide for all future shoreside boiler plant designs with capacities from 7000 lb/hr to 21,000 lb/hr in a 2-boiler plant and 31,500 lb/hr in a 3-boiler plant. One design is for oil or gas (or both) firing only. The other is for coal firing with auxiliary oil or gas where economically justified.

These outline designs can provide general guide lines toward detailed design and construction of your plant. Modifications where economically justified (by comparative calculated analysis, not by abstract judgement) must be made to suit local conditions.

The drawings of the plants shown here are for 21,000 lb/hr steam capacity, expandable to 31,500 lb/hr. Same design, scaled down, can be used for steam capacities as low as 7000 lb/hr, expandable to 10,500 lb/hr. Arrangement of boiler equipment, fuel handling and firing equipment, controls, instrumentation, feedwater system, fans, water treating and testing equipment and other auxiliary equipment are all included. Arrangement generally represents a design that is as austere and compact as possible, commensurate with operating economy.

Oil- or gas-fired plant boilers are of modified scotch marine multipass design, meeting Military Specification MIL-B-17452A (available from the U. S. Government Printing Office, Superintendent of Documents, Washington 25, D. C.). Fuel system for oil-fired plants consists of above-ground tanks for residual fuel oil with suction heaters and a fuel oil pumping and heating system. For gas-fired plants, a general arrangement is shown for a pressure-reducing system and piping to burners.

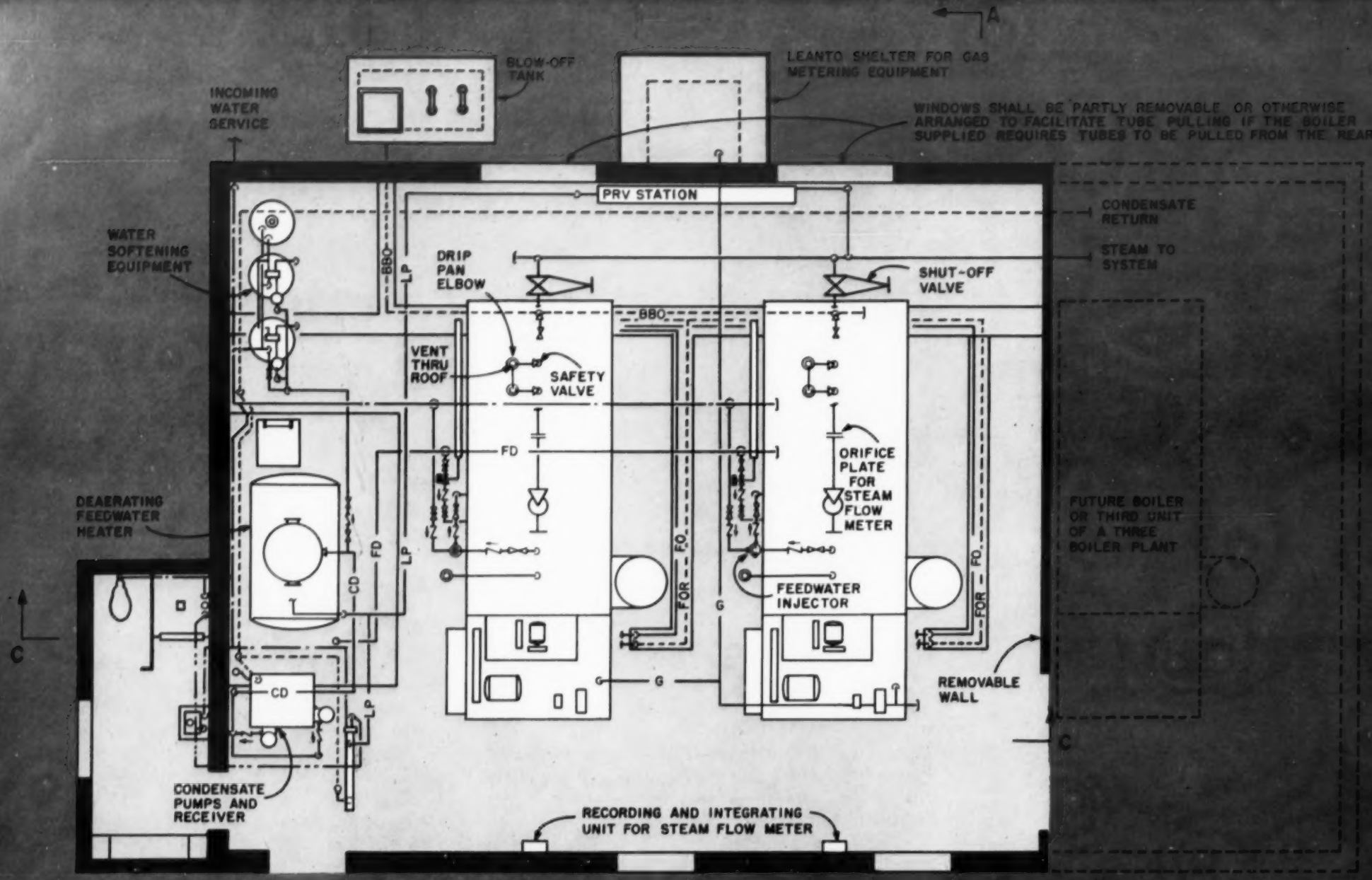
Coal-fired plant consists of horizontal return tubular boilers with average heat transfer through heating surfaces not exceeding 5040 Btu/sq ft. Fuel system consists of a single coal silo and track or road hopper, with slow-speed screw conveyors (to preclude excessive maintenance). System feeds coal to hoppers of single retort underfeed stokers. Ash removal is manual. Ash may be stored in an ash silo, bin, or removable (by truck) container. Where auxiliary oil or gas is provided, fuel storage, handling, and burning equipment is similar to that of the oil- and gas-fired plants. Burner assemblies are provided on boiler fronts with provision for covering grates with firebrick.

designs avoid gold plating

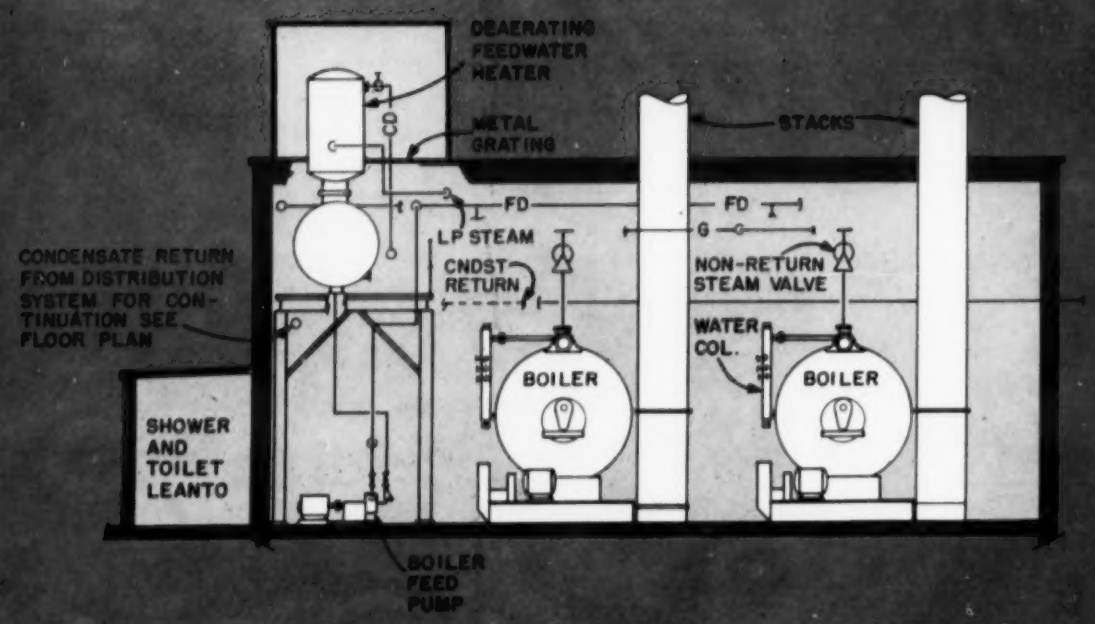
One main purpose of these standardized designs is to preclude overdesign, or "Gold Plating." A factor governing economical plant design is plant size. Only the minimum space required for success-

(continues on page 21)

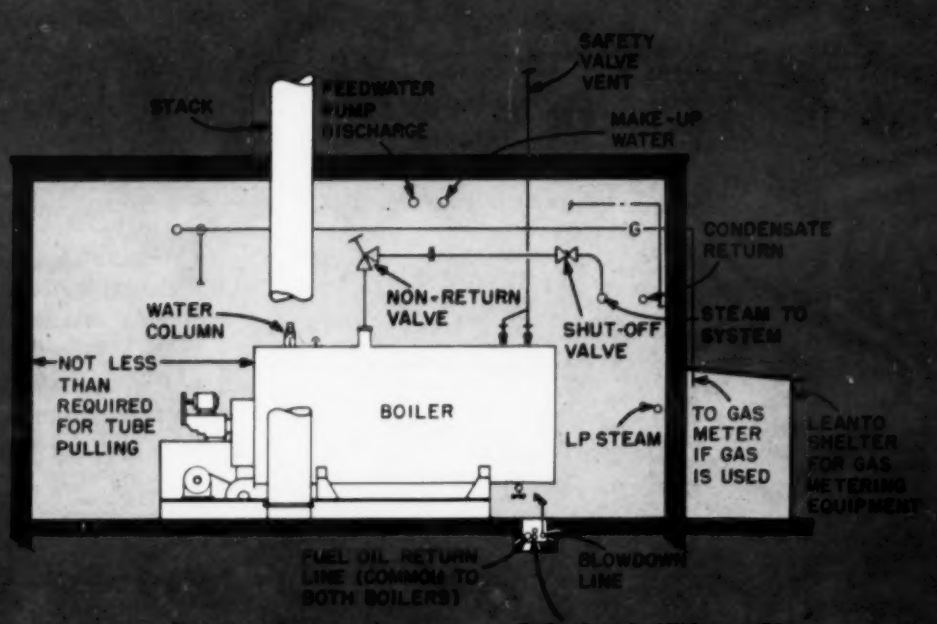
This coal-fired boiler design uses two boilers, but a third one would boost capacity up to 31,500 lb/hr.



FLOOR PLAN



SECTION CC



SECTION AA

ful maintenance (tube removal, soot-blower element removal, and so on) should be allowed in the detailed design. In line with this principle, these maximum dimensions are suggested for guidance in the detailed boiler plant design:

OIL AND/OR GAS ONLY

	2 Boilers	3 Boilers
Capacity	7000 lb/hr	10,500 lb/hr
Length	40 feet	53 feet
Width	30 feet	30 feet
Height	17 feet	17 feet
Capacity	14,000 lb/hr	21,000 lb/hr
Length	41 feet 6 inches	55 feet 6 inches
Width	32 feet 6 inches	32 feet 6 inches
Height	19 feet	19 feet
Capacity	21,000 lb/hr	31,500 lb/hr
Length	43 feet	58 feet
Width	35 feet	35 feet
Height	19 feet	19 feet

COAL WITH OIL AND/OR GAS

	2 Boilers	3 Boilers
Capacity	7000 lb/hr	10,500 lb/hr
Length	36 feet	49 feet
Width	34 feet	34 feet
Height	23 feet	23 feet
Capacity	14,000 lb/hr	21,000 lb/hr
Length	37 feet 6 inches	51 feet
Width	38 feet	38 feet
Height	23 feet	23 feet
Capacity	21,000 lb/hr	31,500 lb/hr
Length	39 feet	53 feet
Width	41 feet	41 feet
Height	24 feet	24 feet

Although plant equipment specification is left to the detailed design, certain salient points are listed.

oil and gas fired package boilers

These boilers are of the 3- or 4-pass modified scotch marine type, complete with integral furnaces, fuel-burning equipment, fans, fully automatic combustion and feed controls, safety devices, and all directly connected boiler trim and accessories. Capacity should be specified in lb/hr steam generation capacity at required steam pressure with 220 F feedwater (supplied from the deaerator provided in this standard plant design). Use of "boiler horsepower" in specifying these boilers should be avoided. This is an obsolete ambiguous term that can mean many things (33,475 Btu/hr; 34.5 lb/hr@ 212 F; 10 sq ft, 6.7 sq ft, 5 sq ft, or 3 sq ft of heating surface) whatever the manufacturer prefers to call it — usually to his own advantage. Maximum average heat transfer in boiler should not exceed 6700 Btu/cu ft.

Oil burners may be air-atomized or rotary cup type. Gas burners may be multiport ring or venturi type. Pilot for either gas or oil ignition should be gas (bottled LPG, if nothing else is available). Fans may be either axial or centrifugal type to provide 10% excess volume at 20% overpressure. Combustion controls should be full-programming (automatic start and stop), modulating, positioning type. Feed controls can be either float-, thermostat-, or electric probe-type operating a modulating control valve or the feed pump directly (on-off). Safety controls consist of flame proving, flame failure, and low water cut-out devices. Boiler and plant design should not require continuous attendance. Attendance once every four hours should be adequate. Oil-fired boilers usually should be designed to burn No. 6 residual fuel oil (Bunker "C").

This oil- or gas-fired design is for boilers up to 100 psig, with capacities as low as 3500 lb/hr each.

coal-fired boilers

These boilers are 2-pass horizontal return firetube type, equipped with single retort underfeed stokers. Boilers must meet ASME code specifications for the pressure desired. Capacity should be specified in pounds of steam per hour. Average heat transfer through heating surfaces should not exceed 5040 Btu/sq ft. Heat release in the furnace should not exceed 35,000 Btu/cu ft. Furnace may be a preassembled package design or built in the field. Standard modulating reciprocating or conservatively designed slow peripheral speed screw-type underfeed stokers may be used. Induced and forced draft fans must be capable of 10% excess volume at 30% overpressure. Grates should be side dumping type to minimize ash handling problems. Where auxiliary oil or gas is to be installed, grates must lend themselves to covering with brick or ash for protection when firing the auxiliary fuel. Combustion controls should be modulating positioning type, capable of controlling stoker feed (or oil or gas valve) in conjunction with the forced-draft fan damper. Induced-draft fan damper should be controlled to keep a 0.1 ± 0.05 in. wg vacuum in the furnace. Safety controls should consist of an overpressure cutout with automatic restart and a low water level cutout that requires manual restart.

It is often wise to buy all boiler trim, sootblowers and piping, fans, stokers, and burners from one source to provide single responsibility.

oil storage and handling

Oil storage, as shown, consists of two aboveground tanks to provide positive head to the fuel oil pumps. Suction heaters preclude wasteful heating of the entire tank. Pump and heater sets should be the integral type, consisting of two pumps and two heaters with capacities such that one pump and one heater can handle 80% of rated capacity.

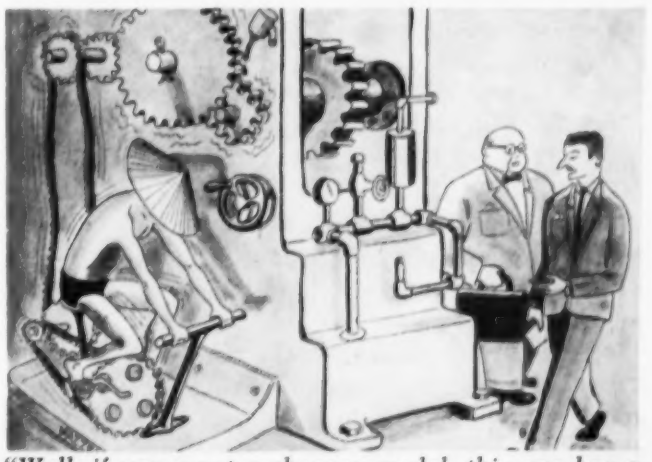
Gas handling and piping consists of a pressure-reducing station and piping to burners, via the regulators.

Coal storage and handling consists of a track or road hopper, coal silo (including elevator), and storage pile that can be reclaimed into this same hopper. Feed from silo to hopper is by slow-speed screw conveyor via a coal scale. Conveyor is automatically started and stopped by boiler hopper level. Ash removal is manual from under the grates and can be removed by a refuse disposal truck arrangement or by storage in ash silo or bin. In any case, the coal and ash handling system must require only one man's attendance.

feedwater system

Duplicate feed pumps are provided, preferably one electric and one steam turbine driven, for heat balance purposes. Deaerating heater should have 6-minutes storage capacity and be capable of providing water with not more than 0.005 cc/1 dissolved oxygen from one quarter load to full load. With respect to deaeration at low loads, tray-type deaerators are recommended unless the plant must operate for any appreciable time at under one-third load. Pot-type feeders are recommended for injection of internal chemical treatment (caustic soda, phosphate and sodium sulphite). External softening equipment, as shown, should be used only where water conditions require external treatment.

In recapitulation, we have presented only the basic outline of a design for plants of 7000 to 31,500 lb/hr capacity that costs least to both own and operate under average conditions. Under these circumstances, it is impossible to go into any great detail. In the final analysis, your new plant must be engineered to suit local conditions. In this respect, the economic principles set forth in "Which Extras Will Pay off in our Next Steam Plant" (INDUSTRY POWER, September 1956) should be used in determining the final design. ♦ ♦



"Well, if you want a cheaper model, this one has a unique drive."

James Mazzetti, Steel & Tubes Div., Republic Steel Corp.

POWER BASICS FOR TODAY'S INDUSTRY

Engineering Economics -- III

How to figure and use fixed charges

Many engineers seem to shy away from financial calculations as they would a visit to the dentist. The subject is avoided because it is not thoroughly understood. But, once explained, it's really very simple. There's no need to go into a trance, drag out a ouija board, or put the job off until next week. The simple facts are presented here in separate chapters and will be reprinted in inexpensive booklet form when the series is complete.

EUGENE S. FERGUSON
Associate Professor of Mechanical Engineering
Iowa State College

with Donald Hartley, Managing Editor

FIXED CHARGES on a piece of equipment are those that must be paid whether the equipment is used 8760 hours (full time) or only a few hours each year.

Three ideas are basic to calculating and using fixed charges in engineering economic studies. Two of these ideas — the time value of money and the sinking fund concept for depreciation — have already been developed. Let's review them briefly before we tackle the third one, the mortgage principle.

Time value of money. A dollar now is worth more than a dollar 10 years from now. We cannot afford to spend a dollar now to save a dollar 10 years hence. If we invest the money now, rather than spend it, it will earn interest and will increase in value.

Obvious as the time value of money may seem, it has a way of disguising itself in actual problems. Many errors of judgment in spending money for industrial equipment can be traced back to a violation of this first principle.

Sinking fund concept should be used to provide for depreciation of a machine or other structure. The sinking fund payment is a constant yearly amount that may be compared directly with another yearly amount, regardless of differences in expected useful life of the equipment involved.

In any engineering economic study, the actual accounting method for depreciation need not be considered, at least until the effect of income tax on a proposed expenditure is explored. Our sinking fund concept recognizes the time value of money. The implied assumption is that any money lying around loose can be invested, either in one's own business or in somebody else's. This brings us to the third idea.

the mortgage principle we know so well

Many of us are familiar with mortgages at first hand. We buy houses, television sets, automobiles, and even dancing lessons "on time." That is, we agree to pay off some of the principal (first cost, present worth) each month or each year, and also to pay interest on the unpaid balance. The resulting monthly or yearly payment is usually a constant amount.

When we start to compare the costs of alternative schemes for doing a particular job in our plant, we should take advantage of this blanket — and basic — assumption:

We should assume that any expenditure for capital improvements — machines, buildings, and so on — is subject to a mortgage contract. That is, over the equipment's useful life, or the payout period, we should assume that we have mortgaged the equipment, and that we must then set aside a constant yearly sum as a mortgage payment. This payment will provide for two of the four items that must be included in fixed charges — interest and depreciation. The other two items — taxes and insurance — will be considered shortly.

Two examples show why the mortgage principle is valid in an economic study. In both examples, let's say that you borrow $100 from a friend for 4 years at an interest rate of 10%.

Example 1. You might plan to keep the $100 for the full 4 years and make an interest payment each year, returning the principal P ($100) at the end of 4 years. But let's say you are afraid that you may not be able to command $100 when it is needed for repayment of the loan. You decide to make a sinking fund payment each year so that, at the end of 4 years, the sinking fund will have grown to $100. Looking up the annual sinking fund payment A in a table, or calculating it from the equation we have already developed, if the interest on the sinking fund is 10%:

$$A = P\left[\frac{i}{(1+i)^n - 1}\right] = 100\left[\frac{0.10}{1.10^4 - 1}\right]$$

Annual sinking fund payment to be made at the end of each year is $21.55.

At the end of each year, then, you will make an

interest payment of $10 and a sinking fund payment of $21.55. At the end of 4 years, the sinking fund will be worth $100, and the debt will be extinguished.

This scheme of repayment is shown graphically in table below.

Example 2. Now, you may object that your money cannot earn 10% in a sinking fund. Therefore, instead of paying the $21.55 into a sinking fund each year, let us suppose you decide that the annual payment you can make to your friend for interest *and* principal reduction is $31.55. As the principal is reduced, you can use a larger proportion of the yearly payment for reducing the principal still further. At the end of each year you will make a total payment of $31.55, and at the end of 4 years, the debt will be extinguished.

This scheme of repayment is shown graphically in table at right.

In effect, the lender has become the holder of your sinking fund. You *earn* 10% interest on the sinking fund because you *save* 10% interest on the amount that goes into reduction of the principal.

This idea can now be formulated. The yearly mortgage payment M will be

$$M = P\ (i + \text{annual sinking fund payment})$$
$$= P\left[\, i + \frac{i}{(1+i)^n - 1} \,\right]$$

Most interest tables have the bracketed quantity in a separate table, but note that the quantity is always equal to the *interest rate* plus the *sinking fund multiplier*.

Consider an FHA mortgage for $10,000. Interest rate is 4½% per year, mortgage term is 20 years. If the debt were paid off in 20 equal annual payments, each payment would be:

$$M = \$10{,}000\left[\, 0.045 + \frac{0.045}{1.045^{20} - 1} \,\right]$$
$$= \$10{,}000\ (0.045 + 0.032)$$
$$= \$10{,}000\ (0.077) = \$770$$

REPAYMENT OF A LOAN: SCHEME 1

AMOUNT OF LOAN: $100
INTEREST RATE: 10% per year
TERM OF LOAN: 4 years

Payment at end of year	*Interest*	*Sinking fund*	*Each sinking fund payment grows, through interest accumulation, to*		
1	$10.00	$21.55			
2	10.00	21.55	$23.70		
3	10.00	21.55	23.70	$26.07	
4	10.00	21.55	23.70	26.07	$28.68

Thus, the total value of the sinking fund at the end of 4 years is $100.00

REPAYMENT OF A LOAN: SCHEME 2

AMOUNT OF LOAN: $100
INTEREST RATE: 10% per year
TERM OF LOAN: 4 years

Note that the sum of these two payments is constant and equal to $31.55

Payment at end of year	*Interest on remaining principal*	*For reduction of principal*	*Unpaid balance of principal*
1	$10.00	$21.55	$78.45
2	7.85	23.70	54.75
3	5.48	26.07	28.68
4	2.87	28.68	0

In its application to engineering economics, the sinking fund amount (or reduction of the principal) is a *depreciation payment*. This depreciation payment remains constant throughout the equipment's useful life or the payout period.

Getting back to the main business at hand, the mortgage idea can be used to calculate a fixed charge rate.

fixed charges are an annual bill

Fixed charges are independent of the use that is made of equipment. They fall due each year whether the equipment is used or not. We have seen that fixed charges can be summarized as:

- Interest that must be paid on the investment.
- A depreciation allowance that must be made.
- Property taxes that must be paid.
- Insurance premiums that must be provided for.

Operating, maintenance, and overhead costs can now be added to the fixed charges to find total annual cost of a proposed installation or alteration. Because the costs are computed on an annual basis, alternatives of different useful lives can be compared directly.

General method for calculation of a fixed charge rate is shown in table at right.

The actual source of the money to be spent has only an indirect effect on the fixed charge rate. Interest rate used in an economic study is not necessarily the rate at which money can be borrowed. Rather, it is the minimum rate of return required to make an investment attractive to management. This idea will be developed further later on.

We must remember, however, that an interest charge must be made whether we borrow money or whether we already have it on hand. We have assumed that any money not being used should be invested in some way. Therefore, whether we invest money in a new piece of equipment or in stocks or bonds, it should pay us a return.

Many electric utility systems use a fixed charge rate of about 15%. Let's see how this rate can be calculated. If interest rate is 7%, equipment life is 20 years, annual taxes equal 5%, and insurance is 0.5% of equipment first cost:

Interest on investment	7%
Depreciation (sinking fund)	2.44%
Taxes	5%
Insurance	0.5%
Fixed charge rate, approximately	15%

We now have all the tools necessary to make a valid engineering economic study. In example 3, the ideas that we have developed so far will be applied to an actual industrial problem.

Example 3. A food-processing plant needs a new pump—a simple centrifugal pump for liquid transfer. What kind of pump shall be installed?

An all-iron pump would do the job, but one with stainless steel trim would last twice as long. Will the added life justify the higher first cost? Let's look at the figures:

FIRST COST	ALL-IRON PUMP	STAINLESS PUMP
Material	$400	$680
Installation labor	150	150
Overhead and contingencies (20%)	110	170
	$660	$1000
Estimated life	5 years	10 years
	ANNUAL FIXED CHARGES	
Interest (8%)*	$ 53	$ 80
Depreciation (sinking fund)		
0.1705 x 660	113	
0.0690 x 1000		69
Taxes (5%)	33	50
Insurance (½%)	3	5
Total	$202 per year	$204 per year

* Note the interest rate. It has been selected by management not because it costs 8% to borrow money, but because any money invested in the business is expected to earn at least 8% return.

All other annual costs—operating labor, maintenance, power, and so on—are assumed to be the

(continues on page 40)

HOW TO FIGURE FIXED CHARGES
using the sinking fund multiplier for depreciation

For industrial equipment:	*Annual fixed charge, shown as % of first cost (principal)*
1. It is bought. Use of money is paid for.	i %
2. It begins to deteriorate immediately and eventually wears out. At the end of its life it must be replaced or the borrowed capital must be returned.	$\left[\frac{i}{(1+i)^n - 1}\right]$ %
3. Property taxes must be paid on equipment.	x %
4. Insurance must be bought or provided for by a reserve fund.	y %

Total fixed charge rate = sum of items 1 through 4.

new bulletins

. . . just circle key numbers on READ-N-CIRCLE card on pages 47 or 48

400-Package boiler specs from 20 to 500 hp

Bulletin 572 gives mechanical specifications on Econo-Therm package boilers featuring off-center firing tube. All units can be fired with gas, heavy or light oil, or combination fuels. Use either forced-draft or induced-draft fans. Four pages. DUTTON BOILERS DIV., HAPMAN-DUTTON CO.

401-Portable steam gun cleans, strips

Steamerette uses existing steam supplies for steam cleaning, paint stripping, phosphating, or sanitizing. Operates with steam pressure from 40 to 140 psig. Quantity and pressure are adjusted at nozzle. Folder A-163-A shows typical uses, outlines mechanical specifications. Four pages. TURCO PRODUCTS, INC.

402-Protect workers when doors are open

Thermostat or door switch activates door heaters when doors are opened. Warm air curtain keeps cold air out, warm air in. Bulletin DH-2A gives suggested door heater sizes, pertinent engineering data. Eight pages. L. J. WING MFG. CO.

403-Solve drive-end space problems

Folder 2489 describes new ball bearing equipment added to Link-Belt screw conveyor component line. Includes examples of how drive-end space problems can be solved with this equipment. Technical data on conveyor screws, trough ends, and hangers aid in selection and application. Six pages. LINK-BELT CO.

404-Underground pipe conduit data

Thermo-O-Tile underground pipe conduit can be used for heat lines, high-temperature hot water systems, hot or cold oil lines. Bulletin 9156 gives installation data, complete specifications, design suggestions. Tells how to install expansion loops. Twelve pages. PORTER-HAYDEN CO.'s.

405-Water conditioning practices survey

"A Survey of Water Conditioning Practices" describes advances in water conditioning methods. Discusses external and internal treating processes that permit maximum re-use of water for maximum operating economy. D. W. HAERING & CO. INC.

406-Performance data on transformers

Esco transformers are available as individual units or single-section unit substations in conventional or special capacities and voltage combinations, direct burial or oil-immersed. New catalog describes transformers for indoor and outdoor applications. Gives useful performance data. ELECTRICAL SERVICE CO.

407-All-metal liquid filter data

LFC Catalog gives data on gpm, pressure drop, inlet and outlet sizes, weight, overall dimensions. Gives required clearance for removing all-metal liquid filter cartridges that filter lubricating, hydraulic, or fuel oils. Capacities from 1.7 to 720 gpm. Special models available for operation at high temperatures and for corrosive materials. Sixteen pages. THE AIR-MAZE CORP.

408-Air-break starters in 2200 to 4800 volts

Type ZHA air-break starters for squirrel cage, synchronous, and wound-rotor motors are described in Bulletin 8130-SC1. Bulletin contains specifications, installation data, possible applications. Four pages. THE ELECTRIC CONTROLLER & MFG. CO.

409-Keep transformer oil high and dry

Centrifugal insulating oil purifiers keep transformer oil high in dielectric strength, reduce free water content. Bulletin 10-107 includes installation photographs, dimensions, capacities, specifications. Four pages. THE DE LAVAL SEPARATOR CO.

410-Convert meter capacities to any fluid

Handy feature in Catalog 2 is section of sizing nomographs that convert meter capacities from air and water to other fluids. Catalog covers line of recording, controlling, and transmitting instruments for flow, pressure, and density. Equipment listed is available for immediate shipment. Bulletin includes engineering data. Thirty-two pages. FISCHER & PORTER CO.

411-Auto-manual pneumatic loading stations

Bulletin 1031 describes nonseal type auto-manual pneumatic loading stations for combustion control, feedwater regulation, pressure-reduction systems, desuperheating stations. Lists sizes of standard and miniature stations. Gives data on gages, loading and transfer valves, remote set-auto manual, cascade biasing. Eight pages. COPES-VULCAN DIV., BLAW-KNOX CO.

412-Vinyl-backed strapping tape data

Bulletin 74-52 describes 250-pound tensile strength strapping tape with vinyl backing for packaging, bundling, tear stripping. Includes technical data, performance specifications. Eight pages. JOHNS-MANVILLE DUTCH BRAND DIV., JOHNS-MANVILLE CO.

413-Rocking contact voltage regulator data

Rocking contact voltage regulators (Type A, B, and C) for ac generators up to 25,000 kva are described in Bulletin 14B6035C. Regulators maintain constant voltage by changing resistance automatically in the exciter shunt field. Bulletin includes construction and operating features. Four pages. ALLIS-CHALMERS MANUFACTURING CO.

414-Unit substation technical library

Unit Substation Technical Library consists of seven bulletins on different problems connected with substation design and operation. Titles are: "Distribution Substations in System Planning," "Economical Size Substations for 12-kv Distribution," "Converting a Radial to a Primary Network Distribution System," "Master Unit Substations and Their Relay and Control Arrangements," "Integrating Substation and System Planning Requirements to Reduce Over-all System Investment," "Twenty-Five Years of Progress in Unit Substations," and "Use of Handbooks for Substation Planning Purposes." GENERAL ELECTRIC CO.

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415-Explosion-proof level indicator data

Roto-Bin-Dicator has UL approval for use in hazardous atmospheres. Can be installed on bin at any angle. Operates successfully with large, lumpy materials. Bulletin BD-8B gives mechanical specifications, schematic diagrams of automatic bin level control and automatic bin level signal system, and installation suggestions. Four pages. THE BIN-DICATOR CO.

416-Magnesium, titanium data

New data book covers magnesium and titanium design data. Includes physical and mechanical properties, mechanical properties at elevated temperatures, metal weights, forming characteristics, specification tables, corrosion behavior, surface treatments, welding and joining, machining, heat treatment and stress relief. Forty-four pages. BROOKS & PERKINS INC.

417-How to select belt conveyor idlers

Rex-Rated belt conveyor idlers are divided into four service requirement classifications: series 1000 for moderate service, series 2000 for standard service, series 3000 for heavy service, and series 4000 for super service. Bulletin 56-80 gives idler selection charts. Examples help in selecting proper belt conveyor idler for specific service requirement. Sixty-four pages. CHAIN BELT CO.

418-Glass cuts smokestack corrosion

Permaglas smokestacks are glass-protected inside and out to protect against acid condensate, thus reducing corrosion. Bulletin SS-202 pictures typical installations. Includes useful installation data. Eight pages. A. O. SMITH CORP.

419-Buying silicone lubricants?

Bulletin 6-101 gives properties and performance of various silicone oils, greases, and compounds. Includes helpful technical data. Compares high-speed, high-temperature ball bearing life using both organic and silicone-soap lubricants. Covers influence of bearing load, speed. Eight pages. DOW CORNING CORP.

420-You, too, can be a cable expert

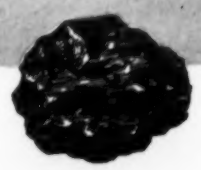
Bulletin 1106 describes four best-known methods for applying insulation to electric conductors. Gives advantages and disadvantages of each. Gives tips on choosing right cable design for most applications. Twenty-eight pages. THE OKONITE CO.

421-Hose clamp manual

Punch-Lok hose clamps are used for leakproof hose connections, for seizing and splicing, and for other miscellaneous repairs. Catalog 300 gives specifications for standard type hose clamps, grooved hose fittings, and special tools and replacement parts. Gives details of Punch-Lok method, tells how to appy Punch-Lok clamps. Twelve pages. PUNCH-LOK CO.

422-Annunciators supervise control systems

Catalog describes Scam standard annunciator systems for constant supervision of control systems and machinery. Can be used for backlighted nameplates or bullseye indication, sequential alarm identification, optional ringback, or manual reset functions. Catalog includes pertinent engineering data, tables of standard sizes and dimensions. Twenty pages. THE SCAM INSTRUMENT CORP. ♦♦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Charleston Rubber Company leads the field in manufacture of superior protective products for linemen and high voltage workers.

Among CHARCO products are: high voltage and linemen's protective rubber gloves and sleeves, including FLEX-SAF Contour Cuff Gloves; "Bulldog" blanket and wire clamps; "Bulldog" utility flag clamp and danger flags; and other products for safety.

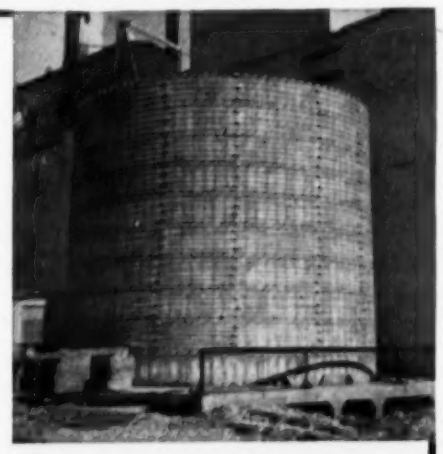
WRITE FOR FREE CATALOG OF LINEMEN'S PROTECTIVE EQUIPMENT
It illustrates many products and gives instructions on care and use

This new illustrated catalog, for use in public utility and industrial electrical fields, tells of the company's program of research and how protective equipment is manufactured and tested. Also it lists technical reports available free

CHARLESTON RUBBER COMPANY
44 STARK INDUSTRIAL PARK
CHARLESTON, SOUTH CAROLINA

Circle 148 on READ-N-CIRCLE card for more data

Neff & Fry Bin Being Erected for Handling Silica Sand



When photographed, this Neff & Fry Super-Concrete Stave Bin was being erected for the Ottawa Silica Co., Ottawa, Ill. It is the first of two 28′ x 40′ bins which are now completed and in use. Silica sand is supplied principally to glass manufacturers, foundries, and concrete producers.

Through our experience in building thousands of bins, we have mastered the techniques of handling and storing virtually all kinds of flowable bulk materials. This knowledge is at your service upon request. You are invited to communicate with us.

To understand the special advantages of our unique type of construction, ask for our folder, "Bins with the Strength of Pillars."

NOT EXPORTED EXCEPT TO CANADA AND MEXICO.

THE NEFF & FRY CO. • 120 Elm St., Camden, Ohio

NEFF & FRY SUPER-CONCRETE STAVE STORAGE BINS

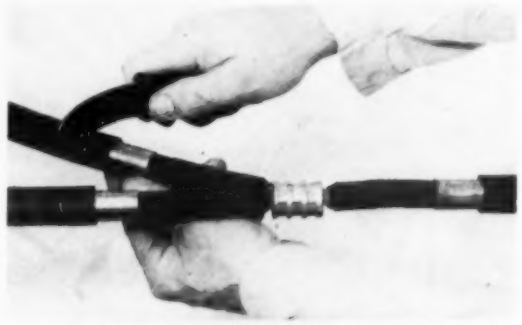
Circle 101 on READ-N-CIRCLE card for more data

new products

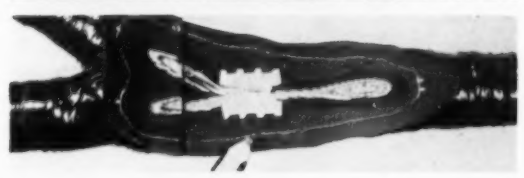
. . . just circle key numbers on READ-N-CIRCLE card on pages 47 or 48

700-Pressure plastic insures insulation

Versatile method, using pressured plastic, protects and insulates electrical splices with epoxy resin injected into a mold. An open-mesh, screen-like tape is used as a spacer material, wrapped around the splice. Tape

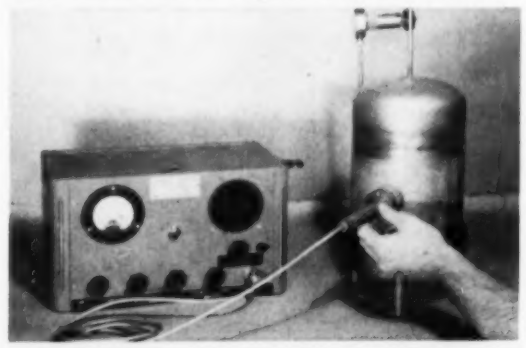


is then covered with a liquid-impervious plastic tape that has an injection fitting to permit entry of resin into the splice. Plastic tape is covered with a low-stretch tape to restrict expansion of plastic when forced into the splice. Adaptability allows mold to be tailormade for each splice. Resulting splice is moisture proof, void free, has high dielectric strength, and can be used for nearly any size or shape of splice. Resin is supplied in a divided plastic envelope, which holds resin on one side, and a hardener, or activator on the other. When divider is broken, resin and activator mix, forming a resin which sets up or cures through internal heat. Plastic envelope is inserted in



pressure gun (similar to caulking gun), envelope is punctured, and gun is ready to operate. Shielding can be made continuous through the splice by running it through the spacer tape buildup. Required insulating values may be regulated by increasing or decreasing plastic thickness. MINNESOTA MINING AND MANUFACTURING CO.

701-Indicates liquid metal level



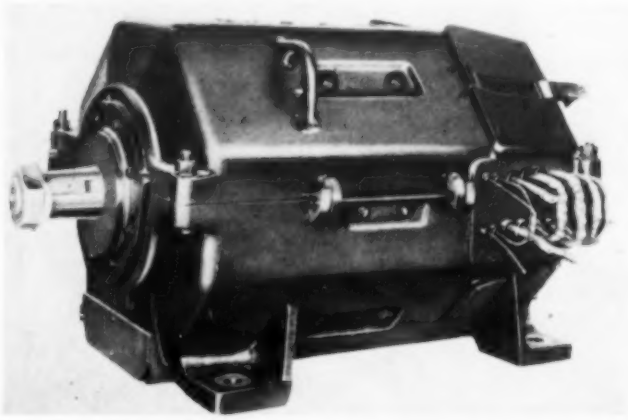
Liquid-metal level indicator is sensitive to changes in height of 1 mm. Indicator is based on a balanced inductance bridge circuit and can be adapted to different container wall thicknesses by varying oscillating signal frequency. Present circuiting limits container to nonmagnetic wall materials, although modifications will permit use of magnetic containers. NUCLEAR DEVELOPMENT CORPORATION OF AMERICA.

702-Get packaged ceiling lighting

Packaged ceiling lighting system permits wide variations in installations with a few standard parts. Modular, interchangeable plastic panel system can be installed in a wide variety of overall patterns of color, form, texture, and style. Vinyl plastic ceiling diffusers are available in three different designs and a variety of pastel colors for subtle atmosphere. Provides flexibility in ceiling illumination. SYLVANIA ELECTRIC PRODUCTS INC.

703-Mill motor is really rugged

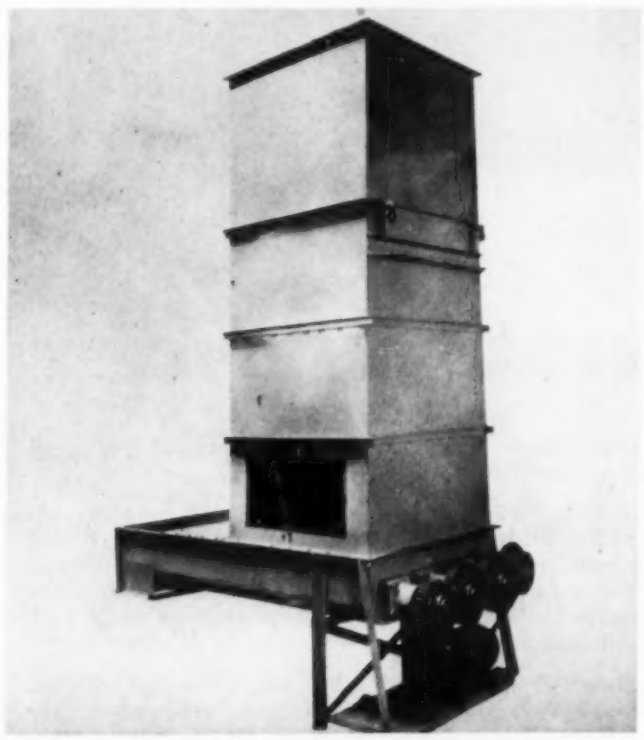
Heavy-duty, silicone-insulated mill motor, type 620 mc, is now available. New motor features cast-steel, split-type frame, integral bearing and housing as-



semblies, large-diameter shaft between bearing supports, and compact mechanical design. Available in ratings from 275 to 360 hp depending upon motor enclosure used. Built to meet AISE standards as to ratings and dimensions. WESTINGHOUSE ELECTRIC CORP.

704-Hopper handles sticky materials

Accurate weighing and discharge of sticky materials is provided with new bell-shaped weigh hopper. Variable-pitch screw feeder provides discharge from the hopper. Weigh hopper is fully enclosed for dust-proof



operation. Hopper can be discharged manually or automatically with mercury magnetic cutoff. Optional equipment includes automatic printer, remote indicating equipment, and automatic totalizing counters. Available in capacities from 50 to 1500 lbs. Gearhead motor is fully enclosed. Hopper suspends from beams and terminates in a dial head. Can be fed from any type of conveyor system. RICHARDSON SCALE CO.

(more new products on page 28)

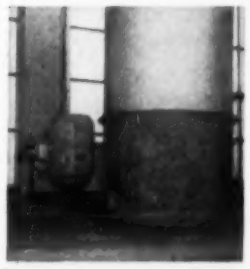
Suitable for high temperatures and corrosive atmospheres, "SP-7" Belt-Driven Duct Fans are available in 14" to 60" diameters.

"SP-7" 7-blade semi-pressure DUCT FANS!

Installed at the Columbus, Ohio plant of North American Aviation, Inc., these new Aerovent "SP-7" Belt-Driven Duct Fans, with 7-blade "Macheta" Airfoil Propellers, are used to exhaust acrid fumes and steam vapors from a spray-type processing machine. At temperatures of 180° to 200° F., the solution flashes into steam and noxious fumes which would contaminate the entire area if unabated. Located above each end of the spray section, and at intermediate points, the fans induce a steady flow of air through the unit to trap and remove heavy vapors at the source.

Recommended for resistances in the ¾" to 2½" S.P. range, these units, designed for all standard duct systems, move *more air* with less horsepower; provide greater mechanical efficiency with lower initial and operating costs. Also available in Direct-Connected, Extended Shaft, Direct Driven Duct and Divided-Duct types, all "SP-7" Fans may be ordered with special-duty motors, alloy propellers and special protective coatings for extreme temperature, moisture and corrosive conditions.

WRITE FOR FREE BULLETIN NO. 400



REMOVES DUSTS, VAPORS, FUMES

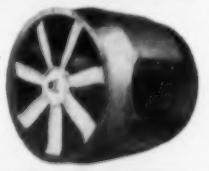
Contaminated atmospheres are exhausted safely, efficiently with "sp-7" Belt-Driven Duct Fans! Complete assembly, except motor, mounts inside duct system. Adjustable motor base for correct belt tension. Air-insulated belt housing for adequate cooling, prolongs belt and bearing life.

All "SP-7" Fans are rated in accordance with the Standard Test Code and conform with U.S.D.C. Comm. Std. CS178-51.

"SP-7" FANS FOR ALL INDUSTRIAL REQUIREMENTS

DIRECT CONNECTED
Steel ring or square panel for wall, ceiling or penthouse. 14" to 60". Used with extended shaft for heat, moisture and corrosion.

"BI-FLO" DUCT
New divided-duct design, for air-supply or exhaust. Motor located out of airstream. Also serves as stack booster. Sizes 18" to 48".



DIRECT-DRIVEN DUCT
For installations which permit connection of complete fan assembly within airstream. For vertical or horizontal use. Sizes 14" to 60".

"EFFICIENCY-ENGINEERED" air-moving equipment

Aerovent Aerovent FAN COMPANY, INC.
Ash and Boyd Sts. Piqua, Ohio

Circle 144 on READ-N-CIRCLE card for more data

new products

. . . starts on page 26

705-Roofing compound uses fiberglass

New liquid-glass roofing compound can be used for insulating, waterproofing, and as a rust preventive. Contains a fiberglass binder that permanently binds compound together. Provides a tough, non-cracking, yet flexible leathery surface on any roof. Also may be used as a long-lasting protective coating on storage tanks and pipes. Available in 5-gallon drums, compound is not as flammable as tar, dries in only 12 hours, withstands temperatures of −25 to 140 F. Can be obtained in either black or aluminum. Guaranteed to remain watertight for at least 12 years without renewal. One gallon covers about 40 square feet. Can be applied directly over a previous coating. MALLARD MANUFACTURING CORP.

706-Strainers and pilot are built in

Built-in pilot and main valve strainers are incorporated in pressure-reducing and regulating valve for steam service. Maximum inlet pressure is 250 psig at

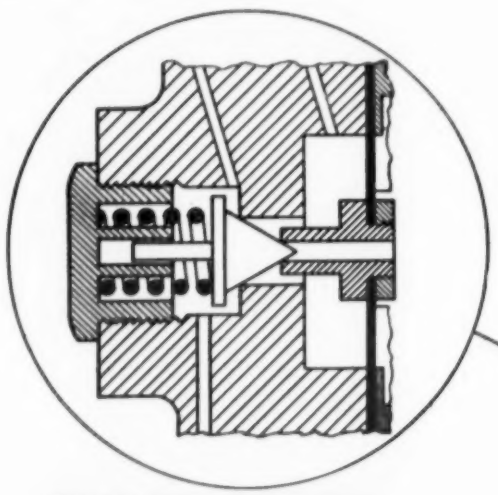
400 F. Delivery pressures range from 5 to 250 psig. Valve sizes are 2-, 2½-, 3-, and 4-inch with iron body and flanged ends. Valve is single seat, internal pilot-operated, piston-actuated. Is highly sensitive to small changes in reduced pressure. A. W. CASH CO.

TO PNEUMATIC OPERATORS

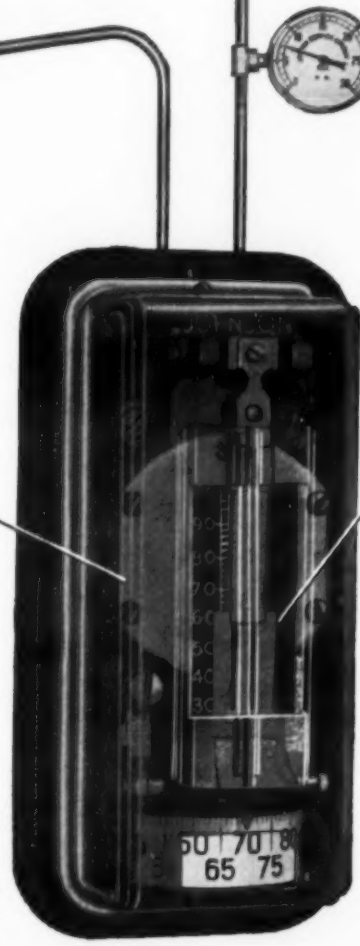
AIR PIPING. Is unaffected by short circuits, capacitance, inductance, temperature, relative humidity; it need not be placed in conduits or insulated.

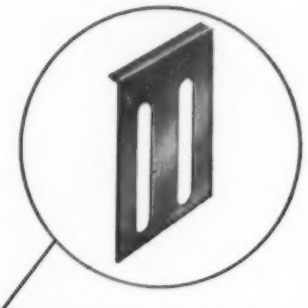
CONTROL PRESSURE GAUGES May be located as desired to observe operation of the system.

FROM AIR COMPRESSOR



SIMPLE VALVE MECHANISM · The heart of the Johnson Thermostat.





MEASURING ELEMENT Low-mass, bi-metal temperature measuring element is capable of *any required sensitivity.* What could be simpler?

TYPICAL JOHNSON PNEUMATIC ROOM THERMOSTAT No additional amplifiers, relays or other remotely located auxiliary components are needed. It's all here in one compact unit under the cover. Johnson thermostats for measuring temperatures and pressures in ducts, pipes, etc., and controllers for relative humidity are equally simple.

INSURE SYSTEM-WIDE SIMPLICITY

For All Types of Industrial and Commercial Applications—Air Conditioning • Heating • Cooling • Ventilating • Humidifying • Dehumidifying • Processing

The basic components of Johnson Pneumatic Control, shown above, reveal how remarkably simple and free from complication the best control systems can be.

The Johnson Room Thermostat—the world's most accepted thermostat—is a refined reducing valve in a compressed air line, set and reset automatically by an accurate bi-metal temperature measuring element, to transmit compressed air, at varying pressures, to valves, dampers and other devices.

Johnson Diaphragm Valves and Damper Operators are equally simple devices with flexible, long-life diaphragms which are moved as the thermostat transmits changes in air pressure. Only pneumatic control gives you system-wide simplicity.

The widespread use of pneumatic power by other industries offers further evidence of its simplicity and adaptability. Examples include truck and train brake systems, industrial power tools, hoists, bus suspension systems, lubricating equipment, machine tools and countless others.

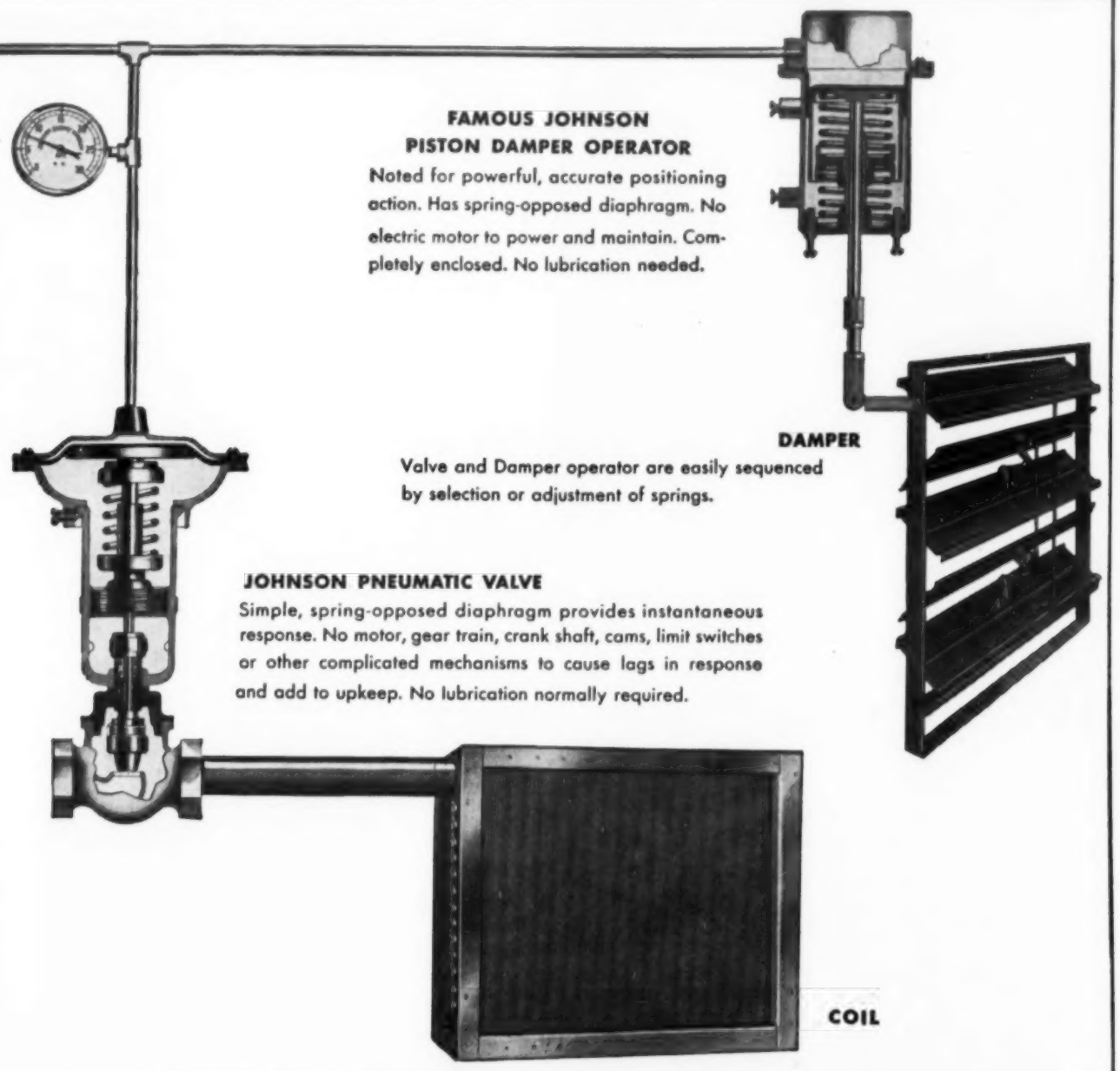
Compare *systems* carefully. You'll discover that Johnson pneumatic apparatus is simpler by far and that you can do control work with just a fraction of the components that would otherwise be required.

JOHNSON CONTROL

SINCE 1885

PLANNING • MANUFACTURING • INSTALLING

Circle 150 on READ-N-CIRCLE card for more data



FAMOUS JOHNSON PISTON DAMPER OPERATOR

Noted for powerful, accurate positioning action. Has spring-opposed diaphragm. No electric motor to power and maintain. Completely enclosed. No lubrication needed.

DAMPER

Valve and Damper operator are easily sequenced by selection or adjustment of springs.

JOHNSON PNEUMATIC VALVE

Simple, spring-opposed diaphragm provides instantaneous response. No motor, gear train, crank shaft, cams, limit switches or other complicated mechanisms to cause lags in response and add to upkeep. No lubrication normally required.

COIL

WITH JOHNSON PNEUMATIC CONTROL

YOU'LL BE BETTER SATISFIED with PNEUMATIC BECAUSE TODAY'S PNEUMATIC CONTROL

- *Has fewer components per system.*
- *Is highly accurate, dependable—has fewer components subject to failure.*
- *Is easier to operate—easier, less costly to maintain.*
- *Offers the widest choice of compensating, sequencing and other operating features.*
- *Provides the necessary flexibility to solve even the most intricate control problems.*
- *Is completely safe under all conditions.*

Let Johnson demonstrate how the advantages of pneumatic control can be applied to your specific problems. Use the coupon or call in a nearby Johnson engineer. No obligation, of course.

WIDEST EQUIPMENT SELECTION

Johnson makes the most complete line of pneumatic control equipment for solving any problem of temperature, humidity or pressure control. Equipment includes thermostats, recorder-controllers, valves, dampers, damper operators, pressure regulators, humidostats, humidifiers, thermometers, switches, special controllers and related apparatus.

Complete engineering, sales and service facilities are available through 104 direct branch offices in the United States and Canada.

JOHNSON SERVICE COMPANY
507— East Michigan Street, Milwaukee 1, Wisconsin

☐ Please have a Johnson engineer call on me.
☐ Send your condensed catalog of Johnson equipment.

Name_____ Title_____
Firm_____
Address_____
City & State_____

Circle 150 on READ-N-CIRCLE card for more data

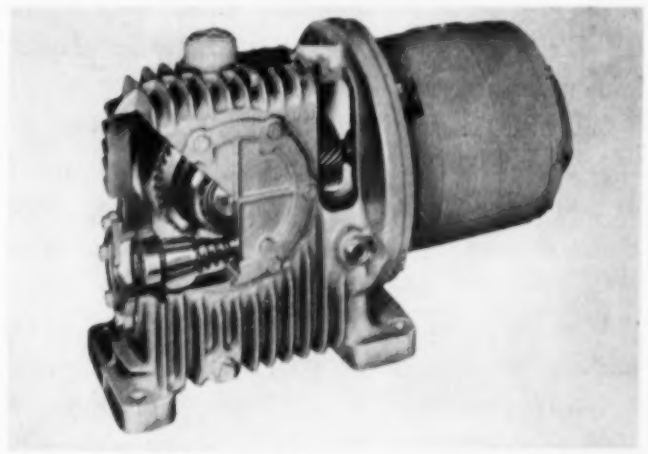
707-Fills battery cells automatically

Automatic cell-filling device permits easy, rapid filling of battery cells to correct level. When preset level is reached, a small, concentric tube transmits vacuum to diaphragm-operated valve that shuts off water flow.

Adjustable stop on fill tube can be preset to any electrolyte height. Accurate electrolyte height in individual cells is maintained without danger of overflowing. Operates under plant water supply pressure from 20 to 50 psi. Can also be used to wash off cell tops before filling, with vent plugs in place. GOULD-NATIONAL BATTERIES, INC.

708-Gearmotors drive at right angles

Compact design, high capacity, and long life are features of new line of right-angle worm gearmotors. New units expand lines from fractional to 40 hp. Output speeds range from 6.25 to 525 rpm. Standard NEMA



D-flange motors are used and gearmotors are available with or without motors. Noted for its extremely high load-carrying capacity on small center distances. CONE-DRIVE GEARS, DIVISION MICHIGAN TOOL CO.

(more new products on page 30)

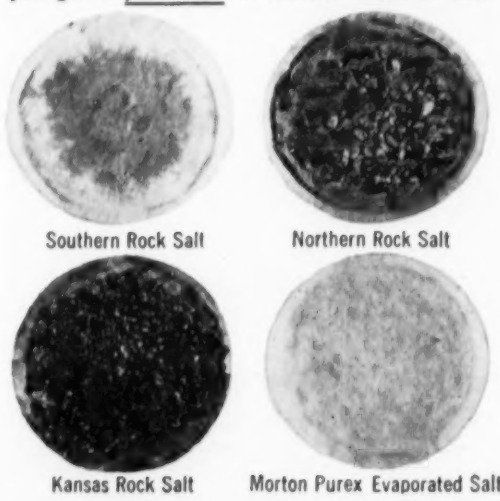
Switch to sludge-free Purex Salt

In every 100 lbs. of rock salt you buy you assume the risk of paying for up to 5 lbs. of insolubles or sludge—shale and sulphates. This means that in a 50-ton carload of rock salt you may pay for as much as 5,000 lbs. of sludge! This insoluble matter is included in the purchase price of the rock salt and accounts for part of your freight bill. It also necessitates periodic cleaning out of your brine making system.

But when you buy Morton Purex Salt, you get high-purity evaporated salt that is made in a controlled particle size to prevent packing and channeling. With Purex, none of your purchase price or freight bill goes toward paying for insolubles or sludge.

With Purex, no time or labor is wasted in cleaning out insoluble matter from your brine making system to keep it functioning at peak capacity. For Purex is 100% soluble. Morton Purex Salt will leave no accumulation of material in either the brine or water softener tanks. It can be used in bulk wet storage systems and in the Morton Model E Brinemaker.

These filter pads (approximately 1/5 actual size) show you how much insoluble matter (sludge) you get in just 5 lbs. of various kinds of salt.



Tests for insolubles taken from these random samples show you that Morton Purex is the only one that contains no wasteful sludge, or insolubles.

For more information about Morton Purex Salt and for free, expert help on any water softening or brine making problem, write or wire:

MORTON SALT COMPANY
INDUSTRIAL DIVISION
Dept. 14, 120 So. LaSalle Street,
Chicago 3, Illinois

Circle 112 on READ-N-CIRCLE card for more data

new products

. . . starts on page 26

709-Plastic panels pass fire test

Full-scale fire test has earned "Fire-Snuf" fiberglass-reinforced plastic panels Factory Mutual Laboratories approval as fire-retardant type. Test was conducted with maximum temperature of around 1200 F. Test showed fiberglass-plastic material to be highly fire retardant, combustible under direct flame, but not flame transmitting. Test proved conclusively that panels would in no way contribute to flame spread throughout an industrial plant in the event of fire. THE RESOLITE CORP.

710-Single-phase power runs arc welder

New arc welding machines with capacities of 180 and 250 amp can operate on single-phase, 230 volt, ac input power. Machines will operate equally well either as an ac transformer-type welder or a dc rectifier-type welder. Switch on front panel changes welder from ac

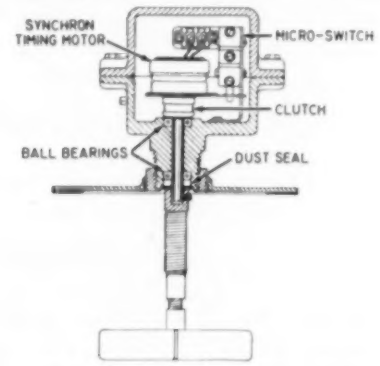
operation to dc positive or dc negative. Power factor correction condensers and special input voltages are available as optional features. Continuous current control is provided for entire range of welding heat. Overload protection, and an arc stabilizer are optional equipment on the 250-amp model. THE LINCOLN ELECTRIC CO.

711-Air conditioners come in six sizes

Packaged air conditioners are now available in six sizes with 3-, 5-, 7½-, 10-, 15-, and 20-ton ratings. Efficient, sloped cooling coil design permits greater cooling area for a given coil size as compared to flat designs. Overload cutout are included in the compressor motor and fan motor circuitry. Compressor is provided with a thermal cutout to stop motor if temperature exceeds predetermined limit. Condenser is equipped with fusible plug to release refrigerant in the event of excessive pressure build-up. High-low pressure controls insure maintenance of operating pressures within prescribed limits. New plenum design has adjustable louvers for horizontal and vertical discharge of air. AMERICAN BLOWER, DIVISION OF AMERICAN-STANDARD.

712-Bin level indicator is explosion-proof

Explosion-proof Roto-Bin-Dicator earns UL label for hazardous atmospheres Class I, Groups C and D; and Class II, Groups E. F. & G. Is designed to indicate or control level of any bulk material that will flow. Indicator particularly suited for application on bins under



pressure or vacuum. Low-torque motor rotates a paddle at slow speed. Material building up to paddle level stops paddle and stalls motor. As motor stalls, motor torque actuates a Micro switch—to control signal lights, horns, conveyor motors, or feeding machinery. THE BIN-DICATOR COMPANY.

MORE INFORMATION

For more detailed free information on these products just circle the key numbers on a READ-N-CIRCLE card on page 47 or 48.

713-Burners fire No. 5 fuel oil

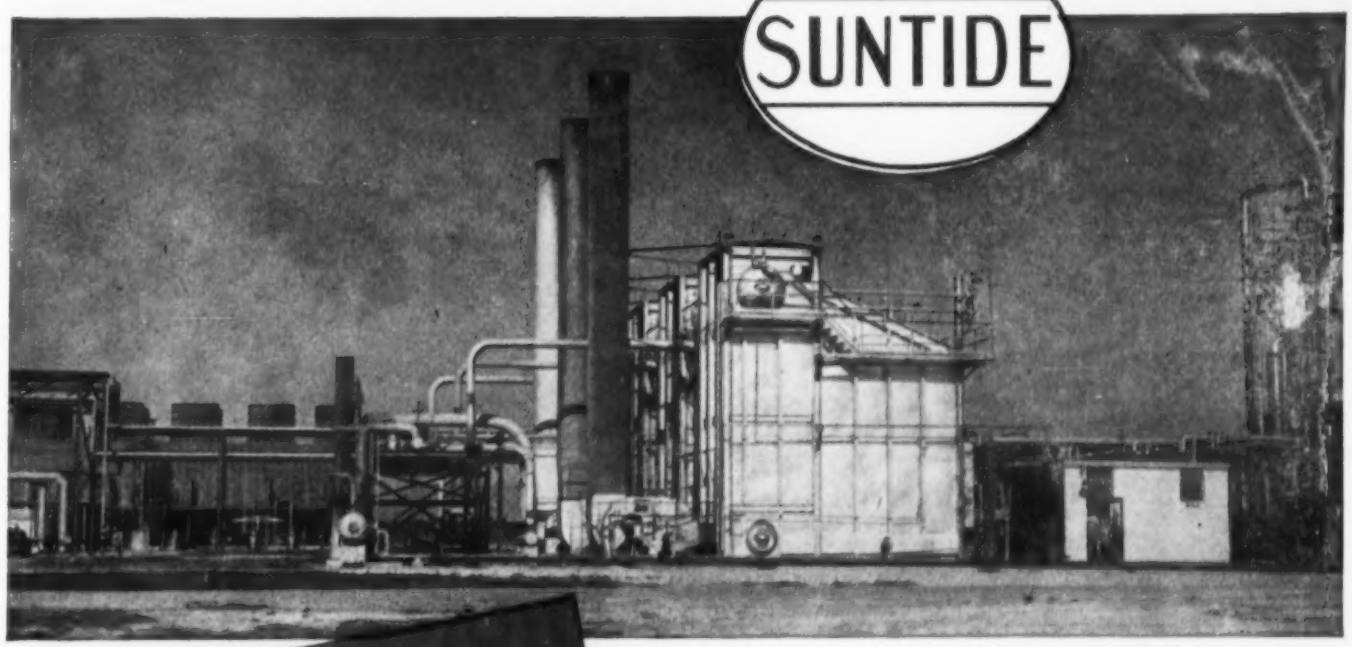
MicroMist oil burner reduces even heavy No. 5 fuel oil to a highly combustible microscopic mist. Simple, direct, electric ignition system is used to ignite fuel oil. Units are shipped as a package, factory wired and tested, ready for installation at the job site. Oil is mechanically atomized as it passes with primary air into the compressor. Compressor-atomizer reduces oil spray, by heat of compression, to a microscopic air-oil

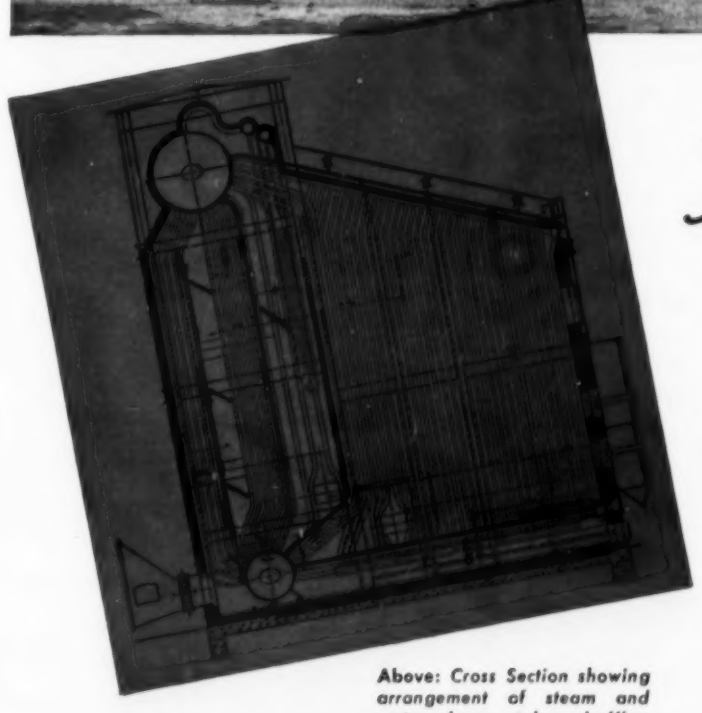
mist. Can be applied to all types of existing boilers or used as a component part of a packaged boiler-burner unit. Wide variety of safety and operating controls is available. IRON FIREMAN MANUFACTURING CO. ♦♦

Vogt

STEAM GENERATORS

at **SUNTIDE REFINING COMPANY**
Viola, Texas





Above: Cross Section showing arrangement of steam and water drums, tubes, baffles, and furnace.

3 Units Installed
2 Units on Order

Principle Data Each Unit

- 85,000 pounds steam per hour capacity, designed for 500 lbs. S.W.P. and 625° F. total temperature.
- Water cooled furnace.
- Burners for Gas and Oil fuel.

Vogt offers a complete line of custom built and package type steam generators. Available in bent tube and straight tube designs for solid, liquid, or gaseous fuels burned singly or in combination.

Write for bulletins. Dept. 24A-BIP

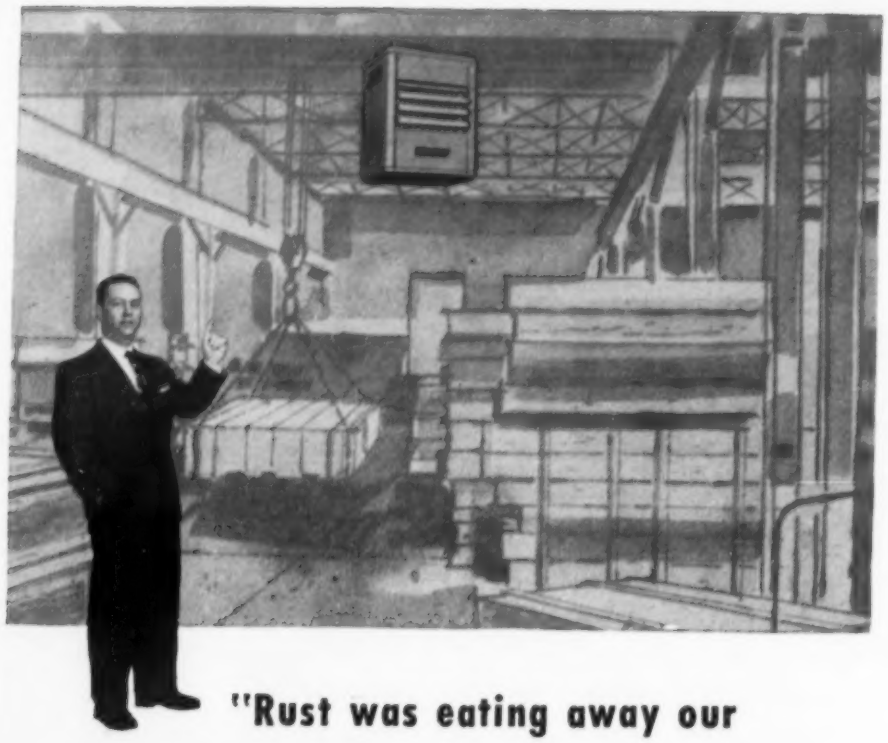
OTHER VOGT PRODUCTS

Drop Forged Steel Valves, Fittings and Flanges—
Petroleum Refinery and Chemical Plant Equipment
Heat Exchangers
Ice Making and Refrigerating Equipment

HENRY VOGT MACHINE CO.
Box 1918, Louisville 1, Kentucky

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati

Circle 128 on READ-N-CIRCLE card for more data



"Rust was eating away our warehouse stocks; these Reznor heaters put a stop to it"

"Rust used to be a serious problem at both ends of our production line. It attacked our supply of sheet steel. And it caused trouble in the warehouses where we stockpile our finished products. One way or another rust was costing us thousands of dollars a year; we could have afforded to pay plenty to stop it. But we didn't have to, Reznor gas unit heaters proved to be the efficient, economical answer to our rust problems. We installed a few Reznor heaters in our steel warehouse and a few more here in our finished products warehouse, set the thermostats and forgot them. Rust is no longer a problem. The heaters are no problem, either. Operating costs are lower than we had expected, and maintenance costs have been zero."

Only Reznor Gas Unit Heating Offers All These Advantages

- Low Equipment Cost
- Low Installation Costs
- Low Operating Costs
- Instant Response to Every Change in Temperature
- No Maintenance Problems
- Wastes No Floor Space
- Extra Heat for Trouble Spots
- Complete Adaptability to Future Construction

For more information mail the coupon below or call your nearby Reznor distributor. He's listed under "Heaters-Unit" in the yellow pages of your telephone directory.

REZNOR
THE WORLD'S LARGEST-SELLING GAS UNIT **HEATERS**

REZNOR MANUFACTURING COMPANY
70 Union Street, Mercer, Pa.

☐ Please send me my free catalog on Reznor gas heating equipment.
☐ Please have a representative call to discuss our plant heating problems.

Name..... Title.....
Company.....
Street.....
City..... State.....

Circle 122 on READ-N-CIRCLE card for more data

basic bulletins

. . . just circle key numbers on READ-N-CIRCLE card on pages 47 or 48

AIR CONDITIONING, HEATING, VENTILATING

500-Air-conditioning history

Development of air-conditioning units from earliest attempts to present-day techniques are discussed in Booklet "Why RK?". Booklet compares three air-conditioning installations as to savings in initial and maintenance costs, on-the-site labor, materials, space, and year-round use. Thirty-six pages. UNITED STATES AIR CONDITIONING CORP.

BOILERS AND BOILER ACCESSORIES

501-Handbook on startup

Handbook covers washing out new boiler, putting it in operation, handling in service, firing methods, and shut down. Includes big section of everyday engineering data. Forty-eight pages. TITUSVILLE IRON WORKS CO.

502-Scotch boiler and stoker know-how

How 94 years' experience in boiler manufacture pays off in better construction is described in Bulletin 236. Gives complete data and test results. Sizes range from 6 hp to 250 hp. Twenty-eight pages. THE JAMES LEFFEL & CO.

BUILDING CONSTRUCTION, MATERIALS

503-How to build better masonry

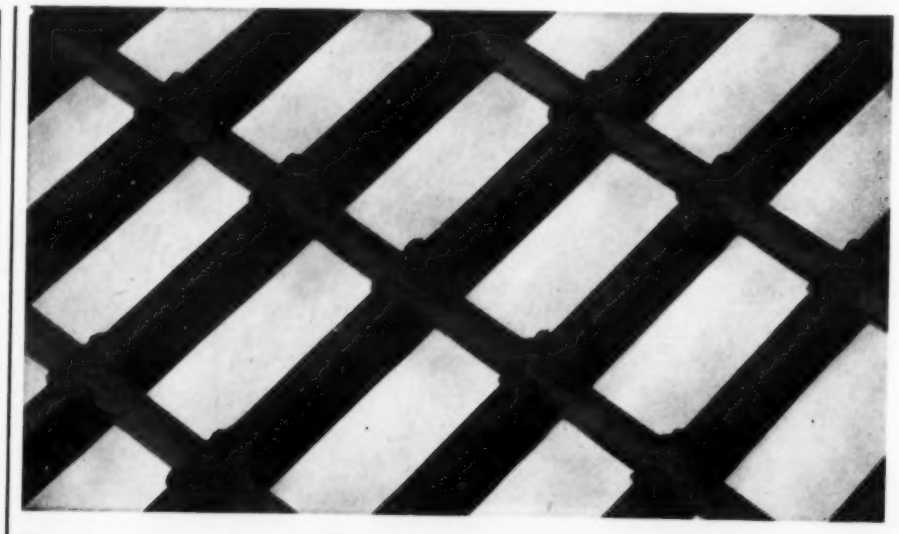
Recommended practice covering materials, proportioning, mixing, and laying of units is offered in Bulletin WP6.55-35M. Three essentials to better masonry and four essentials to better mortar are given with quantity reference tables. Twenty-four pages. UNIVERSAL ATLAS CEMENT CO.

CORROSION CONTROL

504-Protective coatings bulletin

Bulletin 760 presents charts, tables, diagrams, and illustrations showing all factors relating to the use of protective coatings. Discusses surface preparation, priming, application methods, and maintenance instructions. Lists protective coatings for mild and severe corrosive service. Includes table giving

To get more information on products—use the Read-N-Circle card • on page 47-48



Hexagonal Cross Bars...Resistance Welding make

Gary WELDED GRATING safer, stronger neat appearing

One piece construction with tops of all bars flush provides safer, longer-lasting open steel flooring. And it's tailor-made to fit your requirements. For typical installations and full details on Gary gratings, stair treads and decking, write for Catalog IP-47

FREE SAMPLE
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ROCKWELL SPRING & AXLE CO.
Standard Steel Spring Division
4000 EAST SEVENTH AVE., GARY, INDIANA

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chemical resistance rating of each coating to over 200 corrosive agents. Describes method of priming rusty surfaces without previous surface preparation. Thirty pages. U. S. STONEWARE CO.

505-Pocket-size corrosion data

Concise, pocket-size folder describes 11 scale and corrosion control compounds. Contains recommendations for usage, including correct proportions. Compounds are available for scale and corrosion control, oxygen removal, pH adjustment, algae control, etc. D. W. HAERING & CO., INC.

ELECTRIC DISTRIBUTION

506-Factory-assembled unit substations

I-T-E unit substations permit choice of primary devices and liquid-filled or dry-type transformers. Substations consist of one or more transformers with specific devices directly connected to the primary, and metal-enclosed switchgear connected to the secondary. Forms completely integrated, factory-assembled and tested unit. Bulletin 9004-B gives complete engineering data. Twelve pages. I-T-E CIRCUIT BREAKER CO.

507-How to install armor cable

Installation of interlocked armor cable systems is pictured in pocket-size Booklet 19-606. Photographs show terminations and splices; switchgear connections; motors and plug-in bus; special installation problems; typical installations. Before-and-after pictures compare standard wiring system with interlocked armor cable system. Thirty-six pages. GENERAL ELECTRIC CO.

(continues on page 34)

BASIC BULLETINS SUBJECT INDEX

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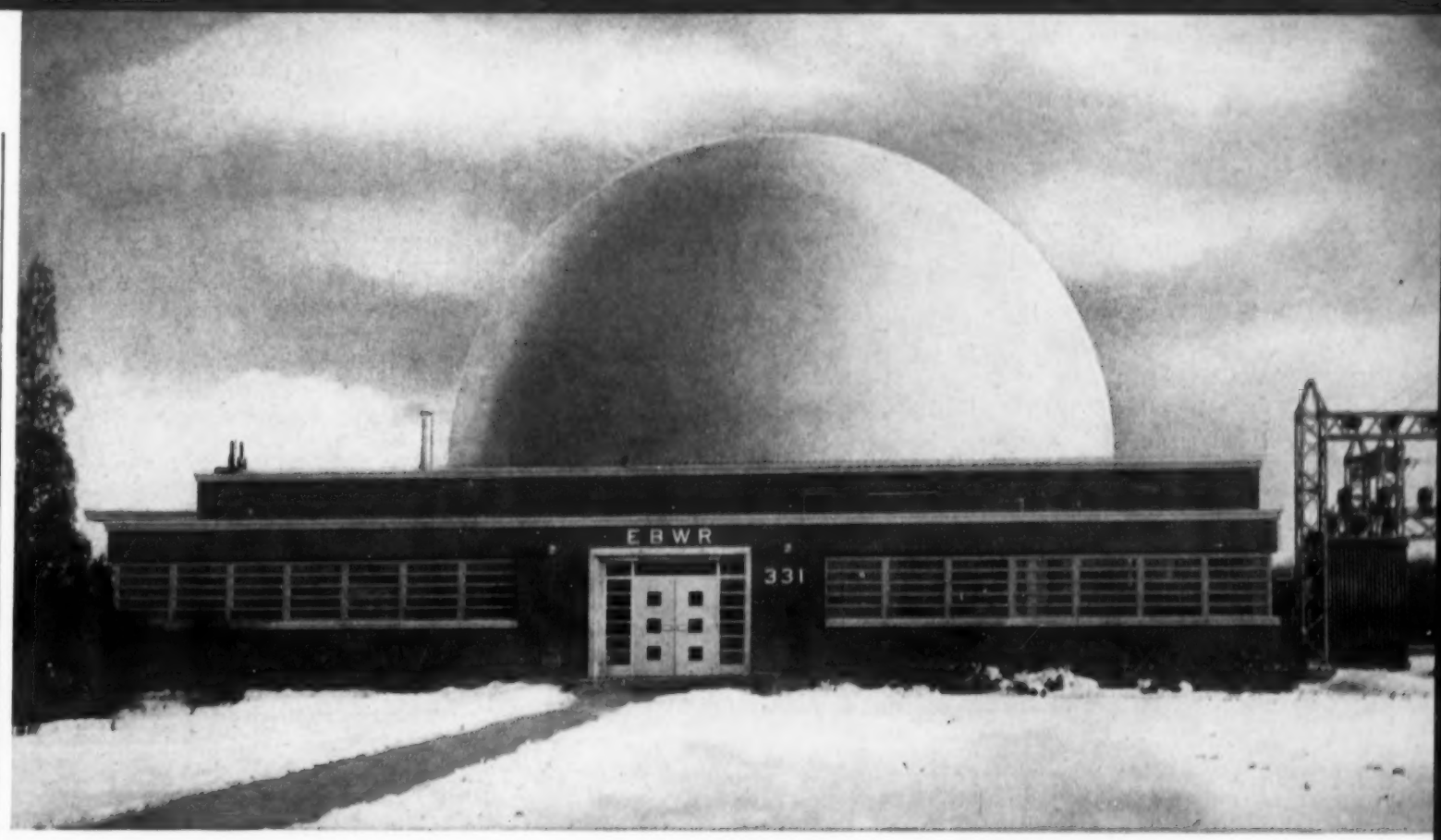

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"Today marks an event of historic significance in man's development of the atom for peaceful purposes. The reactor we are placing in operation today is the first of a generation of such reactors designed to provide electric power for our factories and our homes, power upon which the strength and future well being of this country vitally depends."

from Dedication address, Feb. 9, 1957, by Rep. Carl T. Durham, Chairman, Joint Congressional Committee on Atomic Energy.

EXPERIMENTAL BOILING WATER REACTOR PLANT
Argonne National Laboratory
Lemont, Illinois

TURBINE RATING
5000 kw — 600 psig — 488° F

ENGINEERING AUTHORIZED
August 25, 1954

FULL POWER GENERATION
December 29, 1956

FORMAL DEDICATION
February 9, 1957

SARGENT & LUNDY ENGINEERS
140 SOUTH DEARBORN STREET, CHICAGO 3, ILLINOIS

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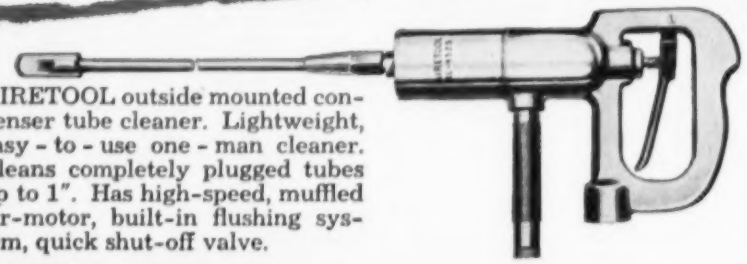
makes every type of tube maintenance tool

Look no further than AIRETOOL for dependable, cost-saving tube maintenance equipment. Precision made Airetool tube cutters, cleaners, expanders, accessory and specialty tools meet **every** tube maintenance need. Save time and money on **every** job.

NEW . . . AIRETOOL Internal Tube Cutter. New single-stage, air-driven motor is designed and built by AIRETOOL. Quickly, inexpensively removes damaged or leaky condenser tubes. Optional electric motor for use where air supply is not available.



AIRETOOL outside mounted condenser tube cleaner. Lightweight, easy-to-use one-man cleaner. Cleans completely plugged tubes up to 1". Has high-speed, muffled air-motor, built-in flushing system, quick shut-off valve.

AIRETOOL Automatic Tube Expansion Control . . . automatically, accurately rolls tube joints to proper tightness. Portable unit goes right to job site.

AIRETOOL Tube Removal Tools are great for retubing a bundle. Quickly and efficiently remove tubes and tube stubs from condenser tube sheets.

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MANUFACTURING COMPANY
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BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.

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EUROPEAN PLANT: Vlaardingen, The Netherlands.
"CANADIAN PLANT: 37 Spalding Drive, Brantford, Ont."

Write for illustrated literature on condenser tube maintenance tools.
Ask for Bulletin #59.

Circle 132 on READ-N-CIRCLE card for more data

basic bulletins

. . . starts on page 32

ELECTRIC GENERATION

508-Generator sets to fill every need

Illustrated Bulletin 6SA20 describes 25 radiator- and heat-exchanger-cooled generator sets from 20 to 245 kw. Available either in 50- and 60-cps units or in dc units. Designed for emergency standby and continuous off-the-line uses. Twenty-four pages. DETROIT DIESEL ENGINE DIV., GENERAL MOTORS CORP.

INSTRUMENTS AND CONTROLS

509-Gas analysis instrument guide

Use and operation of thermal conductivity analyzers for continuous gas analysis is described in Bulletin TD-507. Sixteen pages. ARNOLD O. BECKMAN, INC.

510-All-purpose thermocouple manual

Will thermocouples answer your temperature recording problems? Thermocouple advantages, temperature and pressure ranges, and construction materials are described in Catalog 1556. Sealing gland construction gives positive sealing at pressures from full vacuum up to 20,000 psi. Cutaway sections show all sealing gland components. Time-of-response chart is given for standard thermocouples through temperature range from 0 to 100 C. Twenty-eight pages. CONAX CORP.

MAINTENANCE ITEMS

511-How to choose electric tape

How to choose the electric tape best suited for insulating and protecting applications in construction and maintenance is described in Bulletin 74-10-50. Lists recommendations and performance specifications of plastic, friction, rubber, and vinyl tapes. Colored vinyl tapes in nine colors make color-coding and identification easy. Contains charts giving properties and characteristics of each tape. Twelve pages. JOHNS-MANVILLE.

512-Hose selector slide rule

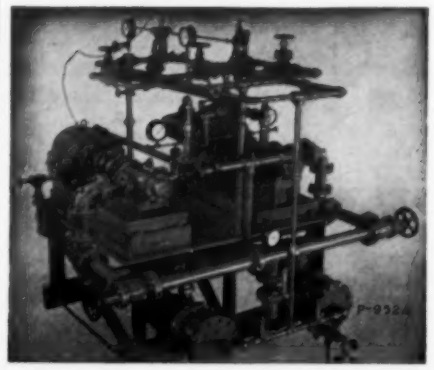
Here's your chance to get a pocket-size slide rule for easy selection of rubber-covered Wiretex hose. Selector contains latest SAE and industry specifications on hydraulic hose. Covers hose diameters from 3/16- to 2-inch id and includes data on working pressures up to 5000 psig. REPUBLIC RUBBER DIVISION, LEE RUBBER & TIRE CORP.

513-Metal saw blade handbook

Problem of selecting correct blade for any metal sawing job is simplified by handy charts in new handbook. Covers selection and use of hand and power hacksaw blades. Recommends cutting speeds, feeds, and techniques. Covers common metal cutting problems and their solutions. Handbook is fully indexed. Thirty-six pages. W. O. BARNES CO., INC.

COMPLETE RANGE OF SIZES AND MODELS IN BOTH MEDIUM AND HIGH PRESSURE TYPES

MORE COMPACT THAN EVER . .



P-152-A—Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-E52H size No. 25 unit.

NATIONAL AIROIL

FUEL OIL PUMPING AND HEATING UNITS

NATIONAL AIROIL Fuel Oil Pumping and Heating Units are specially designed to prepare, for combustion, all grades of fuel oil including No. 6 or Bunker "C" Oil and residuums. They will draw fuel oil from above ground or underground tanks, preheat it to proper constant temperature and deliver it to Oil Burners at an even pressure, best suited for the burners. Our Fuel Oil Pumping and Heating Units are the result of years of experience. They come completely equipped ready for steam, exhaust, condensate, oil suction, oil return, and electrical connections. All valves, regulators, etc., are readily accessible. The piping arrangement is easily understood. These compact, space-saving units are available in a range of sizes and models in both Medium and High Pressure types. For complete details, write for our Bulletin 40—very interesting and informative.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
STEAM ATOMIZING OIL BURNERS
SLUDGE BURNERS, Steam Atomizing
MOTOR-DRIVEN ROTARY OIL BURNERS
MECHANICAL PRESSURE ATOMIZING OIL BURNERS
DUAL STAGE, Combining Steam and Mechanical Atomization
LOW AIR PRESSURE OIL BURNERS
AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
GAS BURNERS
COMBINATION GAS & OIL BURNERS
FUEL OIL PUMPING and HEATING UNITS
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SPECIAL REFRACTORY SHAPES

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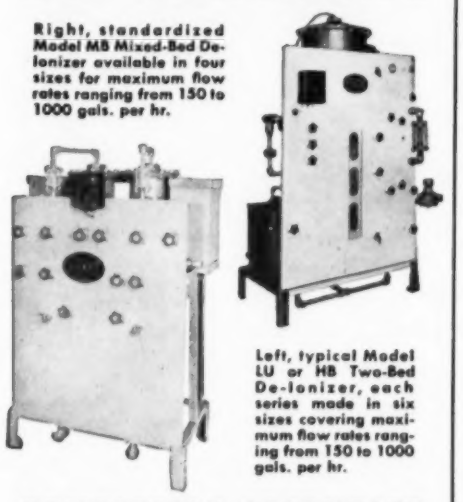
ILLCO-WAY
ionXchange

"PACKAGED"
DE-IONIZERS



Right, standardized Model MB Mixed-Bed De-Ionizer available in four sizes for maximum flow rates ranging from 150 to 1000 gals. per hr.

Left, typical Model LU or HB Two-Bed De-Ionizer, each series made in six sizes covering maximum flow rates ranging from 150 to 1000 gals. per hr.

COMPLETELY ASSEMBLED AND TESTED AT FACTORY

If you can determine the capacity and flow rate you need, you can pick out a *ready-made* ILLCO-WAY unit that is all set to be hooked into your lines and go to work. Three series of models are designed to provide different degrees of water purification and different types of treatment, as required by individual situations. All models and sizes have been thoroughly time-tested and have proved highly satisfactory in hundreds of installations.

READY TO OPERATE AS SOON AS CONNECTED

Each one of these "packaged" De-Ionizers is assembled at the factory, the resins put in the tanks, and the completed unit given a working test. Then, without dismantling in any way, it is crated, and is ready for shipment. *For full details and specifications, write . . .*

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ILLINOIS

NEW YORK OFFICE: 141 E. 44TH ST., NEW YORK 17, N.Y.
CANADIAN DIST.: PUMPS & SOFTENERS, LTD. LONDON, ONT.

Circle 125 on READ-N-CIRCLE card

MATERIALS HANDLING (BULK)

514-Conveyor belt slide rule kit

Two slide rules that cut the time required for designing a conveyor belt installation from 3 hours to 10 minutes are now available as part of a conveyor belt construction kit. One is a horsepower calculator, the other a carcass selector. They incorporate the engineering data in conveyor belting notebook. Forty pages. UNITED STATES RUBBER CO.

515-Story of tile storage bins

"Vitrified Glazed Tile Industrial Storage Bins," four-page Bulletin 1153-B, tells you how this bin can keep materials clean, dry, and ready for use. Drawings show how the tiles are constructed and the simplicity of erecting silos made of these tiles. Solves many industrial storage problems. KALAMAZOO TANK AND SILO CO.

NUCLEAR

516-Produce power with nuclear reactor

Aqueous homogeneous burner reactor for low and intermediate power range is described in Bulletin N-56-8. Includes basic reactor-plant flow diagram. Plant uses a one-region burner reactor as heat energy source. Four pages. FOSTER WHEELER CORP.

517-Electric power from the atom

"Electric Power from the Atom" answers questions on atomic fuel's present status and future prospects, including importance, cost, and what is being done to develop it. Illustrated with maps, charts, and drawings. Includes work of EEI's Technical Appraisal Task Force. Thirty-four pages. EDISON ELECTRIC INSTITUTE.

PIPING, TUBING, AND HOSE

518-Plastic pipe handbook

Bulletin describes threaded- and socket-type fittings and flanges in both normal and high-impact grades. Includes installation information, pressure-temperature charts, chemical resistance tables, and other reference data. Polyvinyl chloride pipe material is resistant to corrosion, inert, non-toxic, and light weight. TUBE TURNS PLASTICS, INC.

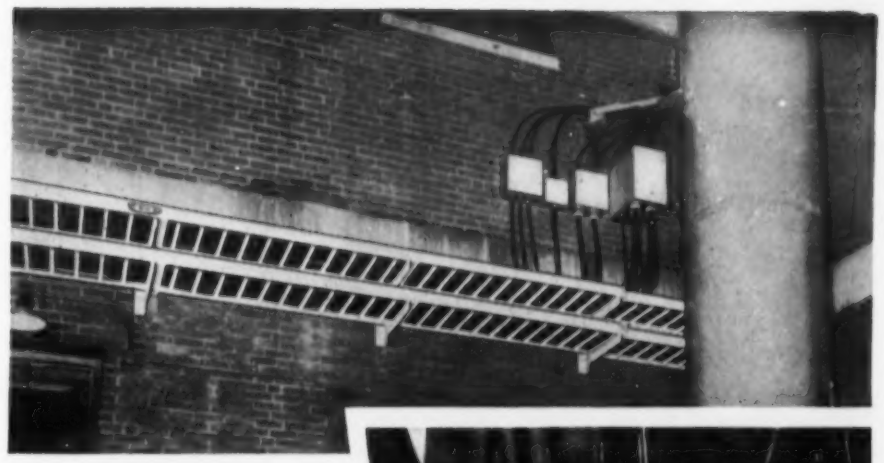
519-Engineering data on tube fittings

Catalog 4310 describes Triple-Lok tube fittings in brass, steel, stainless steel, and aluminum. Shapes include swivel nut-type and straight threaded fittings with O-rings or straight thread boss. Catalog is fully indexed. Fifty-two pages. PARKER APPLIANCE CO.

520-Pumping and sewage treatment manual

Manual 1114 lists seven pump types with comments on advantages of each type. Includes selection chart for determining capacities, pressures, and volumes of each pump type. Gives typical cross section of piping arrangement for industrial and sewage disposal. Lists installation diagrams for bilge or sump pumps showing maximum lift and capacities at various speeds. Gives thorough treatment of pumping and piping problems for all phases of sewage treatment and disposal. Sixteen pages. YEOMANS BROTHERS CO.

(more basic bulletins on page 36)



a new, superior system of
CABLE and TUBING RACE WAYS...

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PAT. PENDING

A completely engineered system of cable ways, production produced and die formed for uniformity with up to twice the strength of ordinary trays, by actual laboratory tests. The universal splice plate joins all parts through the side channels only. All curved fittings are joined at the end of the radius (no tangent material is required) permitting continuous curves. This feature provides greater flexibility of application in tight places and creates an endless variety of combinations for a simple solution to any design problem of change of direction or elevation with a complete set of standard fittings.

Comes in 6", 12", 18" and 24" widths, in standard 12' lengths to further speed up installation time. Cable way can be cut to length at any point—insides and bottom always smooth—all sections punched for easy installation—perfect fit at all times. Neat, clean and uniform in appearance.

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THE GLOBE COMPANY

EASY TO INSTALL • SAVES TIME • SAVES ON MATERIAL
GALVANIZED • NO MAINTENANCE PROBLEM

Write for new complete catalog. Distributors in all principal cities. Contact the Grip-Strut distributor under "Conduits" in the classified telephone directory.

PRODUCTS DIVISION The GLOBE Company
4036 S. PRINCETON AVE. • CHICAGO 9, ILL.

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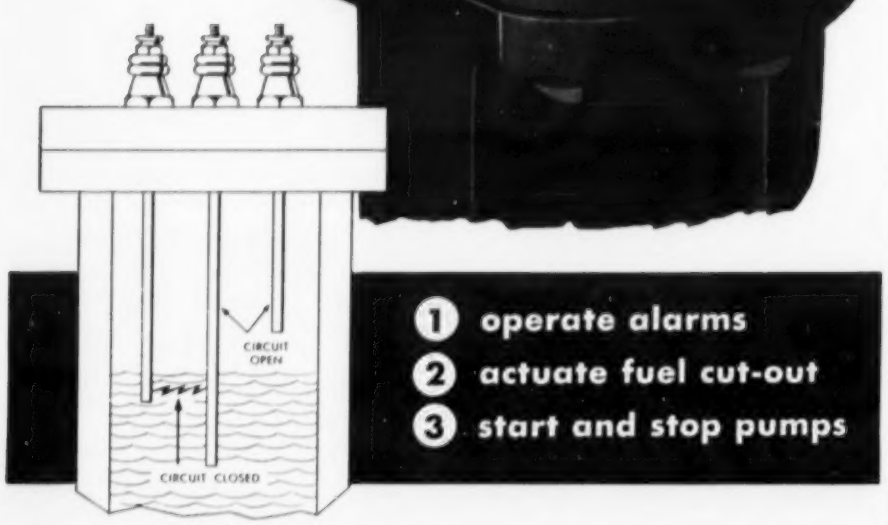
Tiny currents guard boiler safety!

Reliance electrode-type Levalarms®



1 operate alarms
2 actuate fuel cut-out
3 start and stop pumps

For extra safety, guard your boiler water levels with audible and visible alarms that reach operators anywhere in the plant. Or cut fuel automatically, without depending on human action. Here's more protection for boilers working on any pressure to 2500 lbs.

Levalarms operate on isolated electric currents passing through the boiler water itself. When water level gets too high or too low, circuits are made or broken and actuate relays *instantly* to cause ACTION (1, 2, or 3 above).

Four models of Levalarms installed on or in your water columns, provide a selection for various control combinations. Levalarms have no bellows or stuffing boxes; no vacuum tubes or magnets. Action is positive, immediate. Levalarms are unaffected by pressure, temperature or water conditions.

Read the full story of Reliance electrode-type Levalarms in Bulletin D2 sent on request.

The Reliance Gauge Column Company • 5902 Carnegie Avenue • Cleveland 3, Ohio

The name that introduced safety water columns....in 1884

Reliance®

BOILER SAFETY DEVICES

Circle 104 on READ-N-CIRCLE card for more data

basic bulletins

. . . starts on page 32

PUMPING EQUIPMENT

521-Handbook of hydraulic tables

This comprehensive reference work is now available for engineers interested in pumping and piping problems. Bulletin 50 also contains data useful to all engineers. Twenty-eight pages. THE ALDRICH PUMP CO.

REFRACTORIES AND INSULATION

522-Chart simplifies insulation calculation

Useful chart converts gallon quantities into square feet of surface area to aid in estimating material needed to insulate cylindrical vessels. Eliminates complex mathematical calculations when vessels are identified only by gallon size or by length and diameter. ARMSTRONG CORK CO.

TRAPS, STRAINERS, AND SEPARATORS

523-Clean air, gas lines mechanically

Aridifier removes oil, moisture, dirt from compressed gas and air lines by mechanical cleansing action. Catalog 252 gives typical Aridifier applications, data on prices, dimensions, sizes. Eight pages. LOGAN ENGINEERING CO.

TURBINES

524-Turbogenerators from A to Z

Turbogenerator construction, operation, and installation are discussed in bulletin. Includes condensing, condensing extraction, noncondensing, noncondensing extraction, and mixed-pressure extraction units with advantages and limitations of each. Cross section of typical turbine gives excellent understanding of all turbine components. Includes section on lubrication. Thirty-six pages. WORTHINGTON CORP.

VIBRATION AND NOISE CONTROL

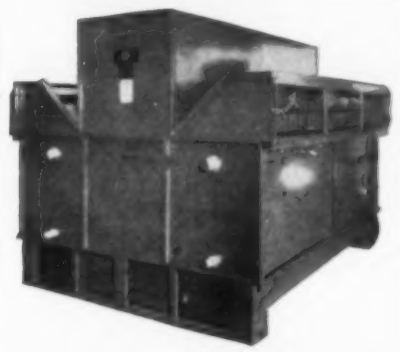
525-Acoustic materials reference

Acoustical Materials Association reference manual is a compilation of architectural acoustics and acoustical materials data. Covers nature and causes of sound, remedies for excessive noise, methods of acoustical analysis for sound-conditioning a given area, installation data on acoustical materials. Fifty-eight illustrations supplement text. ACOUSTICAL MATERIALS ASSN.

WATER SUPPLY AND TREATMENT

526-Water treatment equipment manual

Precipitation and adsorption method of feedwater treatment used in Accelerator and Hot-Flow softeners is described in Bulletin NICSI-A. Covers chemistry of hot process treatment. Compares results of various treatments. Lists equipment and accessories available. Twenty pages. INFILCO INC. ♦♦



NIAGARA SECTIONAL *Aero* HEAT EXCHANGER gives close temperature control, saves you LABOR, Power, Water

- Because the new design improves the heat transfer to the out-door air by evaporation.
- Because new features keep your equipment working for long life with "new plant" efficiency . . . always full capacity.
- Because you save 95% of cooling water cost.

You get faster, more accurate cooling of industrial fluids to specified temperatures.

You improve your quality of production by removing heat at the rate of input.

You save labor in upkeep. With full access to all interior parts and piping you see everything in easy inspections. You head off dirt accumulation and corrosion. Casing panels are removable without moving the coils. The coils can be cleaned from both sides.

First cost is low; freight is low because of the lowest space/weight ratio; you save much labor in erection. Capacity range is 7,000,000 to 18,000,000 Btu/hr. No other heat exchange method gives you so much saving in money and convenience.

Write for Niagara Bulletin No. 132

NIAGARA BLOWER COMPANY
Dept. IP-4, 405 Lexington Ave.
NEW YORK 17, N. Y.
District Engineers in Principal Cities of U. S. and Canada

Circle 111 on READ-N-CIRCLE card

new

OXYGEN ANALYZER

Simplifies Flue Gas Analysis

- INSTANT READINGS— ACCURATE TO ± 0.5% O_2
- OPERATES ON FLASHLIGHT BATTERIES—NO CHEMICALS
- COMPLETELY PORTABLE AND SELF-CONTAINED

The new Model D2 Oxygen Analyzer offers speed, convenience, and versatility for industrial use in such applications as: Excess air measurements to improve combustion efficiency; monitoring air leakage in inert systems: insuring safe entry into mines, sewers, and vessels, etc.

OPERATION IS SIMPLE: Merely squeeze a bulb to draw sample gas into the unit, then press a switch and the oxygen content can be read directly and immediately!

RANGE: 0 - 25% O_2.
ACCURACY: ± 0.5% O_2.
WEIGHT: Only 3½ lbs.

For full details write to:

Arnold O. Beckman Inc.

1020 Mission Street
S. Pasadena 6, California

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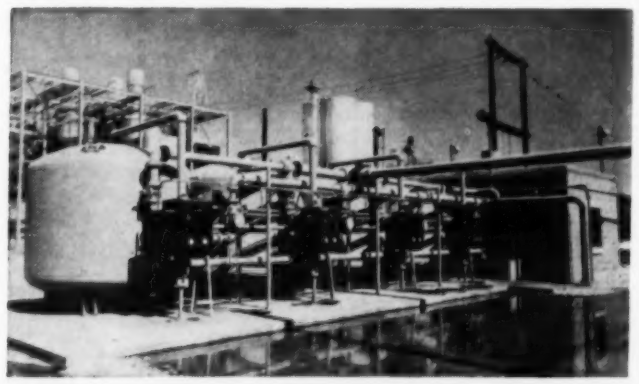

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(for over half a century)

Complete plants for water softening, demineralization, silica removal, de-oiling of condensate, clarification, de-alkalizing and all other requirements.

Send for Bulletin BFT-11
or Nearest Field Representative.

HUNGERFORD & TERRY, INC.
CLAYTON 1, NEW JERSEY

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names make news

. . . personalities from industry power

National Lumber Manufacturers Association appoints **Richard G. Kimbell** acting executive vice president. He has been NLMA vice president of technical services since 1954. He joined NLMA in 1919.

American Institute of Consulting Engineers elects **Edward H. Anson** president. He is senior vice president and director, Gibbs & Hill, Inc., New York City.

Dr. Lee L. Davenport is president of new **Sylvania-Corning Nuclear Corp. Walter E. Kingston** is executive vice president. Owned jointly by Sylvania Electric Products Inc. and Corning Glass Works, new company will take over the two companies' atomic energy businesses.

Watson

Willey

American Brake Shoe Co. elects **Arthur K. Watson** to its board of directors. He is president of IBM World Trade Corp.

American Society of Lubrication Engineers appoints **Calvert L. Willey** administrative secretary. He was formerly with National Society of Professional Engineers as assistant to the executive director.

Dr. Walter H. Zinn, president of **General Nuclear Engineering Corp.,** and the **Florida Nuclear Power Group** have signed a consultant-adviser contract to further prospects of generating electricity from atomic power. Participating companies are Florida Power Corp., Florida Power and Light Co., and Tampa Electric Co.

General Controls Co. appoints **Chester S. Beard** head of its Control Valves and Actuators Engineering Division. ♦♦

THE AIR WE *Breathe...*

. . . . must be safeguarded against contamination. Every public-spirited industrialist realizes the importance of clean air to community good will, plant employee relations and the safety of his plant and its equipment.

Prat-Daniel has made notable contributions, during thirty years of research and manufacture, to the dust and smoke abatement programs across the nation. By promoting good public relations and protecting sensitive machinery, P-D Collectors have performed an outstanding service.

One of the many developments that have contributed to this success is an exclusive, patented, unique design of internal gas flow, known as *PLENAFLO. This feature eliminates recirculation, reduces wear, provides accessibility to every tube and improves efficiency.

The Thermix Corporation, Project Engineers, will be glad to send you a bulletin fully explaining this new idea in tubular design. Ask for Bulletin on P-D dust collectors featuring PLENAFLO.

*Trademark

pd

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THE THERMIX CORPORATION
GREENWICH, CONN.
(Offices in 38 Principal Cities)
Canadian Affiliates: T. C. CHOWN, LTD., Montreal 25, Que.

Designers and Manufacturers
PRAT-DANIEL CORPORATION
SOUTH NORWALK, CONN.

POWER DIVISION: Tubular Dust Collectors, Forced Draft Fans, Air Preheaters, Induced Draft Fans, Fan Stacks

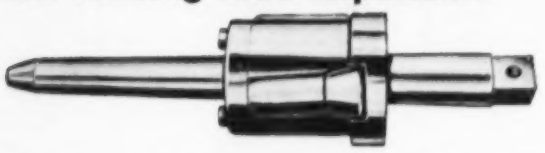
Circle 103 on READ-N-CIRCLE card for more data

Keep boilers on the line with
WILSON
Maintenance Tools

Heavy-duty air driven tube cleaners

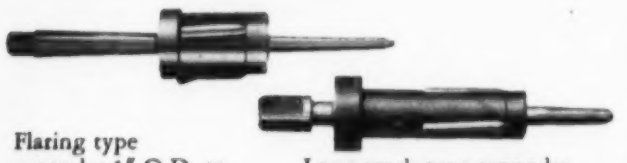
Designed to deliver maximum power at the most efficient cutter head speeds while negotiating sharp bends, the Model ECT Air Cleaners are excellent for cleaning curved boiler tubes from 2½" to 4½" O.D.

Self-feeding tube expanders



Wilson Model 38 tube expanders are self-feeding and parallel expanding. They are of the single flare roll type. Available for tubes 1" O.D. to 4½" O.D. with various roll lengths for tube seats ¼" and up.

Model E Expanders



Flaring type expander 1" O.D. to 4½" O.D. tubes, ½" to 2" tube seats

Long reach type expander 1" O.D. to 4½" O.D. tubes, 2½" to 5" tube seats

Right angle bevel gear drive

This Wilson bevel gear drive is expressly manufactured to meet continuous and heavy duty service conditions. The one piece all steel body is extremely rigid and not subject to distortion. The maintenance of perfect gear alignment is assured with consequent long service life.

Write today for your copies of Wilson Tube Cleaner catalog No. 77 and Wilson Tube Expander catalog No. 88.

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TUBE CLEANERS • TUBE EXPANDERS

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Seventeen climates

. . . starts on page 12

to recirculate a certain proportion of air in the duct system.

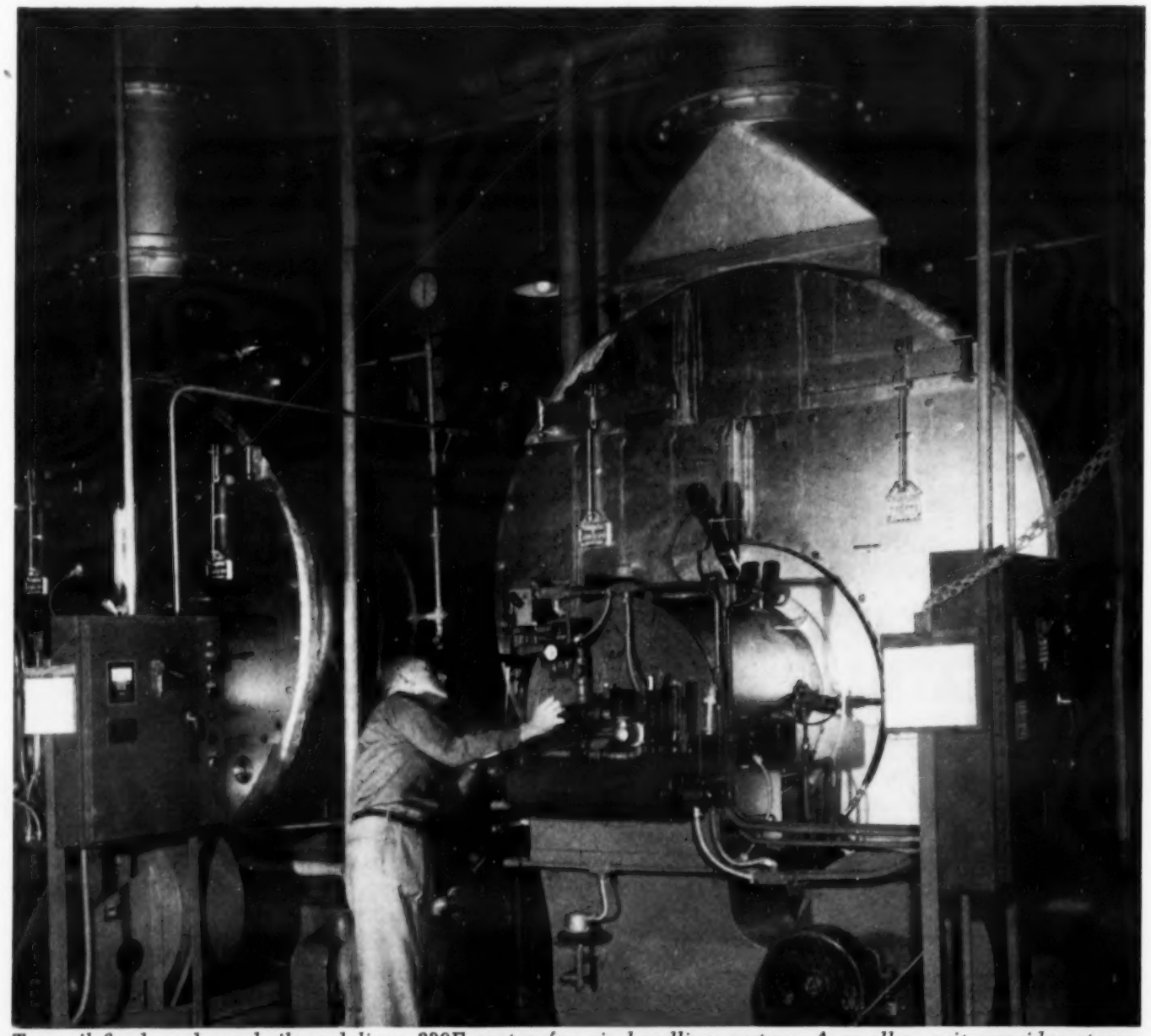
Thirty reheat coils zone the office area by compensating for changing load conditions. Hot water flow in these coils varies in response to room thermostat demand. Air is cooled to a temperature below that required for design outlet conditions to maintain desired humidity. Reheat coils then bring air temperature back to its design value.

Office system provides a basic temperature of 72 F at 35% relative humidity in winter. Heat comes from baseboard radiators. Reheat coils increase or decrease warm air temperature to maintain atmospheric conditions. System provides 80 F temperature at 40% relative humidity in summer, in accordance with previous medical experience.

Conditions in each of the 30 office zones can be altered individually by the occupants. Reheat coils compensate for occupancy, sunlight, and other factors. Thermostats and humidistats are located at points in each zone where true ambient conditions are obtained. These controls actuate air-operated valves, dampers, switches, and other devices.

plant conditions are ideal

Manufacturing-area air conditioning provides ideal conditions for laboratory work and chemical processing of duplicating supplies. This is accomplished with 17 separate air-conditioning units, each serving a distinct area. A unit consists of heating and cooling coils, circulating fan, reheat coil, water atomizer, temperature and humidity sensing devices, anti-freeze devices, filters, motor starters, and valves.



Two oil-fired package boilers deliver 230F water for air handling system. A smaller unit provides steam.

Waxing area has two air conditioners delivering 23,400 cfm at ½-in. static pressure, one at each end.

Plant areas served by units are: laboratories, laboratory office, quality control, supply office, industrial engineering, development engineering, cafeteria, lunchroom, sales office, waxing area, pilot plant, coating area, roll manufacturing, inspection area, rolls area, and humidity room (used for accelerated ageing tests). Approximately 150,000-cfm conditioned air is moved through these areas.

Laboratories, laboratory office, quality control supply office, industrial engineering, and development engineering all have identical temperature and humidity requirements: 80 F at 50% relative humidity in summer, 72 F at 35% relative humidity in winter. Positioning switches open or close dampers bringing in outside fresh air to be mixed with recirculated conditioned air. This reduces danger of air contamination in processing sections.

Each area is divided into five zones. Each has a damper control, allowing zone temperatures to be varied independently.

Air currents can be a problem if they move sheets of processed gelatin and carbon paper. To avoid this trouble, static pressure controls are used in the waxing and roll areas where these supplies are made. These controls maintain a constant atmospheric pressure at all times through sensing devices located inside and outside the pertinent areas.

In the waxing area, a constant 90 F and 50% relative humidity are maintained. In the rolls and inspection areas, a constant 72 F and 65% relative humidity are maintained.

A Powers recording regulator varies conditions in the pilot plant in accordance with process being tested. Temperatures can be varied from 72 F to 90 F, and relative humidities can be varied from 50 to 65%. Recording regulators also are used in the rolls inspection area and humidity room.

Flexibility is the keyword in this modern plant air-conditioning system. It provides for every conceivable operation, both present and future. And all these tailormade conditions are possible by hook-up of standard components. ♦♦

Air conditioning controls are manufactured by The Powers Regulator Company, Dept. IP, Skokie, Ill. For more information, Circle 745 on READ-N-CIRCLE card, page 47-48.

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- In Packaged Boiler and Commercial Heating Applications

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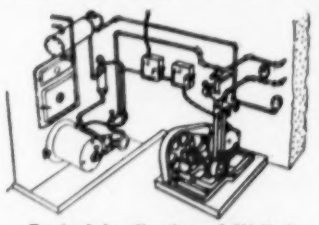
SU PUMP UNITS can be furnished with a wide variety of pumps and motors for pressures up to 300 psi, capacities to 2030 gallons per hour. Sub-assemblies of pump, stub shaft, pillow block and sub-base are also furnished separately as a unit for incorporation into systems by boiler and furnace manufacturers. Write today for complete information.



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Engineering economics III

. . . starts on page 22

same for either alternative. On the face of it, our study tells us to buy the all-iron pump, but the difference between annual costs is small. It is here that the intangibles—judgment factors—come into play. It is much better to have some definite cost figures to weight our judgment, however, than it is simply to reach a decision based on intuition alone.

This example demonstrates a simple, but complete, engineering economic study. Each assumption that we have made will, of course, have an effect on the results. If we use an economic study to try to find out what our final decision should be, it can definitely help us. If, on the other hand, we use the study to prove that a preconceived notion is correct, we can make all our assumptions in such a way that our cause is favored. Then we shall be proving only what old George Canning knew 150 years ago—"you can prove anything with figures."

Other factors, not yet considered, may enter into an economic study. Two of these factors—incremental returns and income tax—will be discussed later.

We have now covered the necessary principles for most engineering economic studies. The one thing that we are most likely to forget in thinking about alternatives is the effect of fixed charges on total annual costs. An economic study is not valid unless we have considered fixed charges along with all other revelant costs. They must be included in any set of estimated cost figures if those figures are to be of any real help in arriving at the best possible solution to our problem. ♦ ♦

"Right now we're interested in the main feeder and breaker layout . . . . we'll worry about an outlet for the coffee machine later on . . . ."

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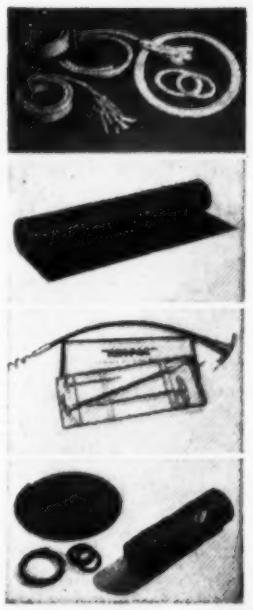

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Make pure water

. . . starts on page 14

broth (after recovery of antibiotics and solvents), waste process water, equipment and floor washings, cafeteria waste, and sanitary waste. Uncontaminated waste water is primarily the discharge from various mechanical processes, such as cooling water. Uncontaminated waste water is not treated by the system, but is used as a diluent for the final treated waste effluent. This is done because of the uncontaminated waste water's large volume and its stable dissolved oxygen and residual chlorine contents.

Antibiotics spent broth is first neutralized with lime and caustic, and the pH is adjusted to a level suitable for subsequent treatment. The neutralized spent broth is then aerated in a pre-seeded tank, or is treated by a modified activated sludge process.

Equipment and floor washings, sanitary waste, cafeteria waste, and laboratory waste first pass through a prechlorination chamber which is followed by a comminutor. Combined wastes then flow to a clarifier. Clarifier effluent flows by gravity to a wet well. Liquid in the wet well is pumped to two high-rate trickling filters where the liquids undergo biological oxidation, flocculation, adsorption, and sedimentation. Filter effluents discharge into a secondary clarifier. Clarified liquid also flows to the wet well to mix with the primary clarifier effluent.

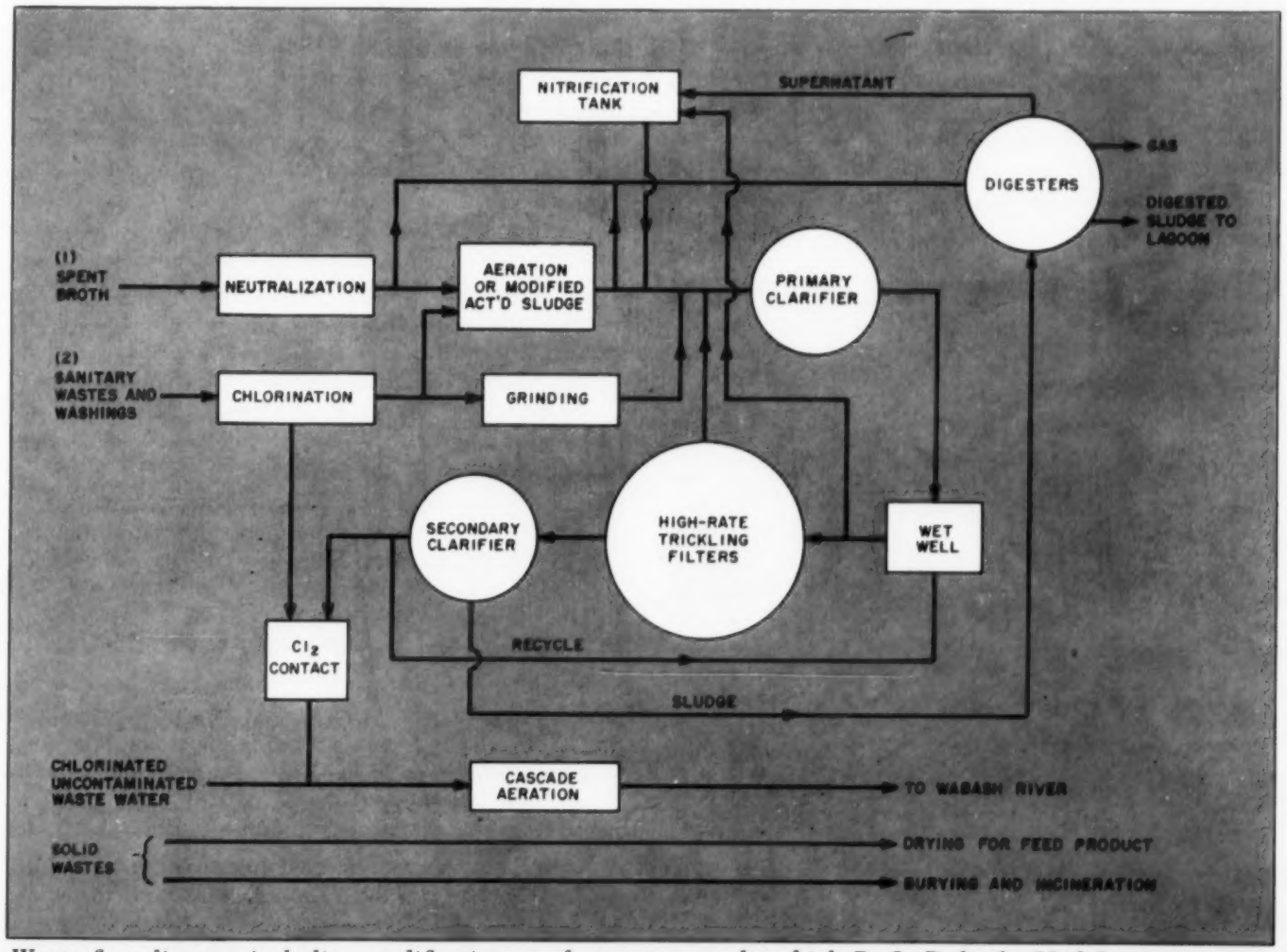
waste treatment flow permits recycling

Clarified effluents may be recycled to the biological filters from the wet well. Effluent thus may be recycled as many as 14 times before leaving system.

Liquid in the secondary clarifier receives chlorination again, or its overflow portion receives post-chlorination only. The bio-filtered and clarified liquid then flows into a chlorine contact tank. Effluent mixes with uncontaminated waste water before gravity discharge into the Wabash River through several stages of cascade aeration.

Solids removed by clarification and scum collected at clarifiers are pumped to the digesters. Here, solids (as sludge) undergo anaerobic destruction by a controlled digestion process (single-, or two-stage). Gas

(continues on page 42)



Waste flow diagram including modifications made to accommodate high B. O. D. loads. Modifications permit recirculation of wastes until desired degree of purification for discharge into the Wabash River is obtained.

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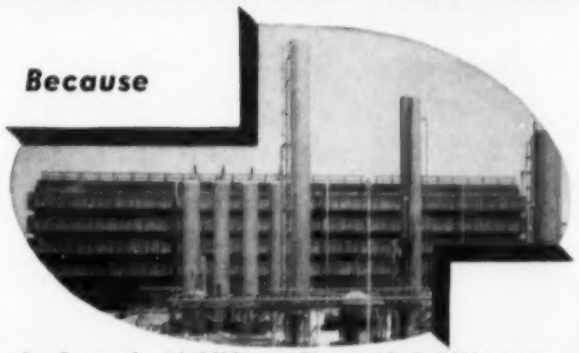

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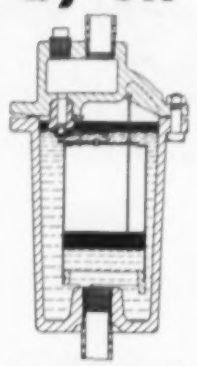

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produced by digestion heats the sludge, the digester building, or is burned in a waste-gas burner. Digested sludge is pumped to five sludge absorbing and drying beds.

Supernatant from the digesters is returned to a nitrification tank. The liquid is stabilized by biological oxidation to further oxidize the ammonia or sulfides as well as other residual organic matter. Nitrification tank effluent discharges into the flow-control pit. It combines with other raw wastes to undergo subsequent treatment stages.

modification to handle high B.O.D. load

Modifications were necessary in 1954 to accommodate a higher B. O. D. load than was considered in the initial design. Another need was to improve treatment efficiency without additional equipment or treatment units. Three major modifications were made. Preaeration tanks are now converted into a modified activated sludge process. Aeration and sedimentation of activated sludge are regulated by operational adjustment. Nitrification tank effluent, formerly discharged into the wet well in the original design, is now returned to the primary clarifier. This change was made because of the high solids content in the supernatant produced by a high-rate digestion process. Clarifiers, designed to serve as primary clarifiers in parallel, were converted into a primary clarifier and a secondary clarifier. This was done because of grease particles and fine suspended solids that require additional clarification after biological filtration.

Graphs and charts, prepared from accumulated daily loading data during the past 30 months, determine the operating control (Figs. 1, 2, 3). With cooperation of production departments, treatment system control has been solved. A satisfactory effluent has been produced even when an unavoidable load is received by the system.

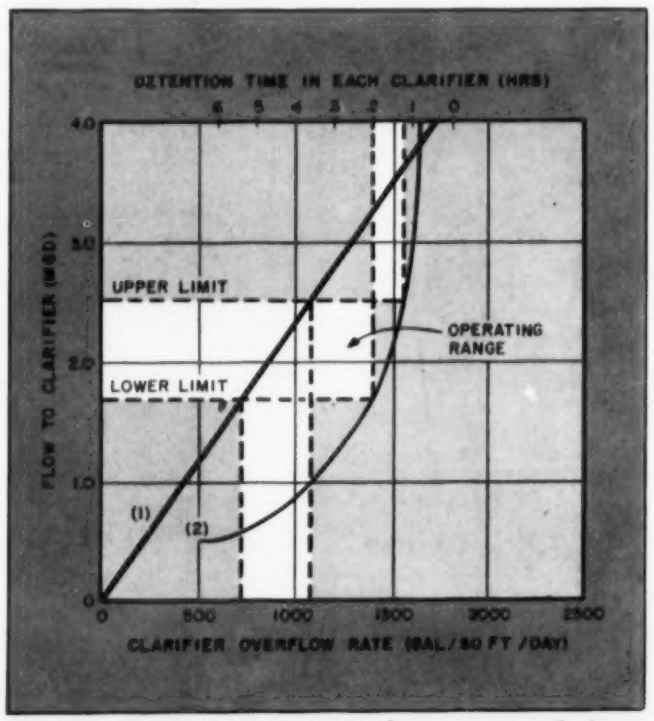

Fig. 1 — Operating control chart prepared from daily loadings gives detention time for each clarifier.

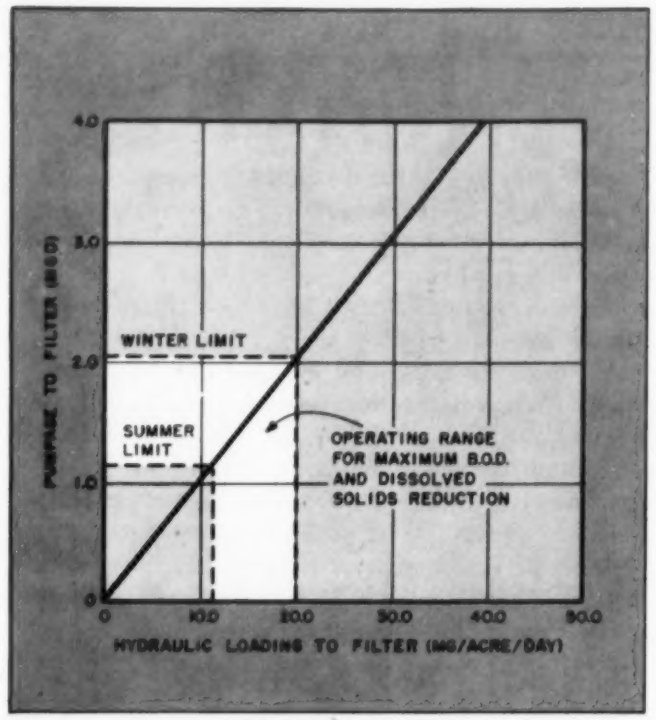

Fig. 2 — Summer and winter hydraulic loading limits are determined from accumulated daily loading data.

During initial waste treatment system design, the products now manufactured at the Laboratories had not been considered. Waste characteristics differ greatly, therefore, from those presented in the initial design. The solution to handling high B. O. D. and solids loadings in the aeration tanks was to check aeration capacities and to improve treatment efficiency if capacities were not sufficient. Antibiotics wastes have a B. O. D. as much as three times stronger than that of the initial design wastes. It was necessary, therefore, to increase treatment equipment or to improve treatment methods, separately or in combination.

no additional equipment needed

Modification of treatment process appeared to be the immediate and economical answer to the high B. O. D. and high solids loading problem. The preaeration system, therefore, was converted into a modified activated sludge process that has proved very efficient. No additional equipment was required. A pumping station was erected to deliver the weaker sanitary waste liquid to the aeration tank to maintain desired solids concentration, temperature, D. O., and pH.

Problems of grease, color, odor, and corrosion have

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...dialed to your exact need
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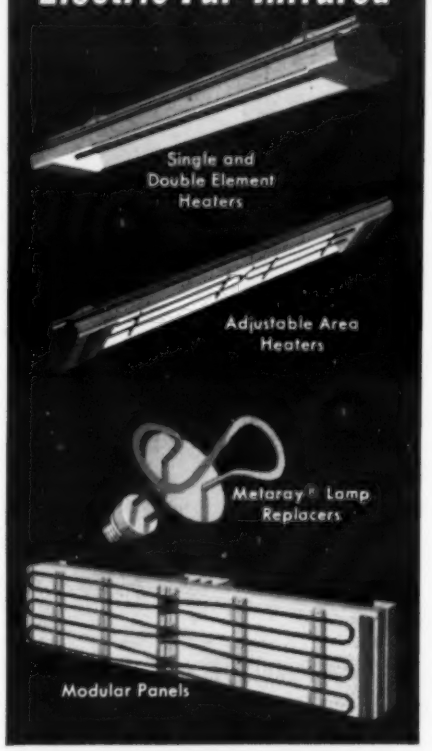

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been studied since the start of this waste treatment system. Grease collector could not handle all the grease discharged at a high flow rate. The effective solution was found to be control of grease discharge. A primary clarifier, and a secondary clarifier to hold minute grease particles that could not be collected by the scum collectors, were provided in the two parallel primary clarifiers. The secondary clarifier effluent now has practically no grease at all.

how color is removed

Color in antibiotics wastes cannot be reduced effectively by coagulating chemicals. Proper biological oxidation and flocculation followed by chlorination and sedimentation, however, can reduce color to a minimum. With little color in the clarifier effluent, color in the final stream discharge is undetectable.

Corrosion is a serious problem because of organic and inorganic acids, fumes, ammonia, hydrogen sulfide, alkalies, chlorine, solvents, and salts in the wastes. Equipment is painted with corrosion-resistant paint. Copper tubing is painted where possible or is replaced by galvanized tubing. Polyethylene tubing replaces copper tubing for instrumentation in some cases. With some metallic or non-metallic parts constantly exposed to corrosive materials or liquids, the corrosion problem is not yet solved.

Odor is a problem that always accompanies organic waste treatment. Odors are of the nitrogen and sulfide types. Efforts to reduce odors have been attempted and experimentation on odor control has been conducted. Major odor problems have been eliminated. *(continues on page 44)*

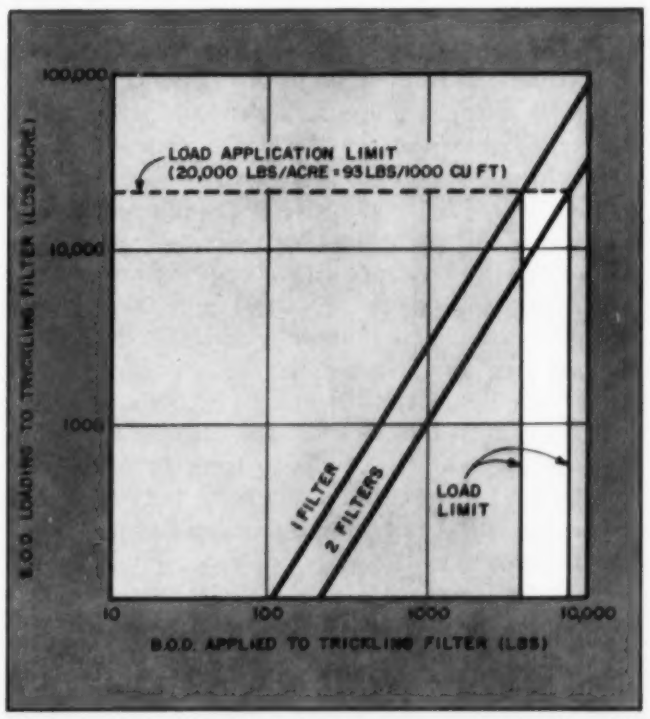

Fig. 3 — By recirculating wastes, second trickling filter is used to increase system filtering capacity.

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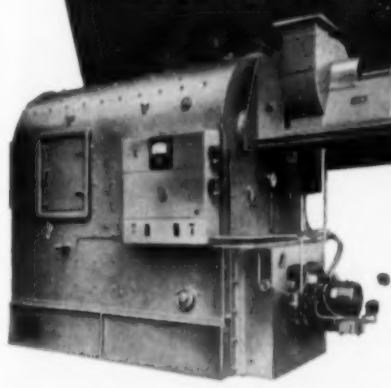

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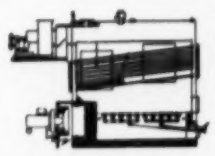

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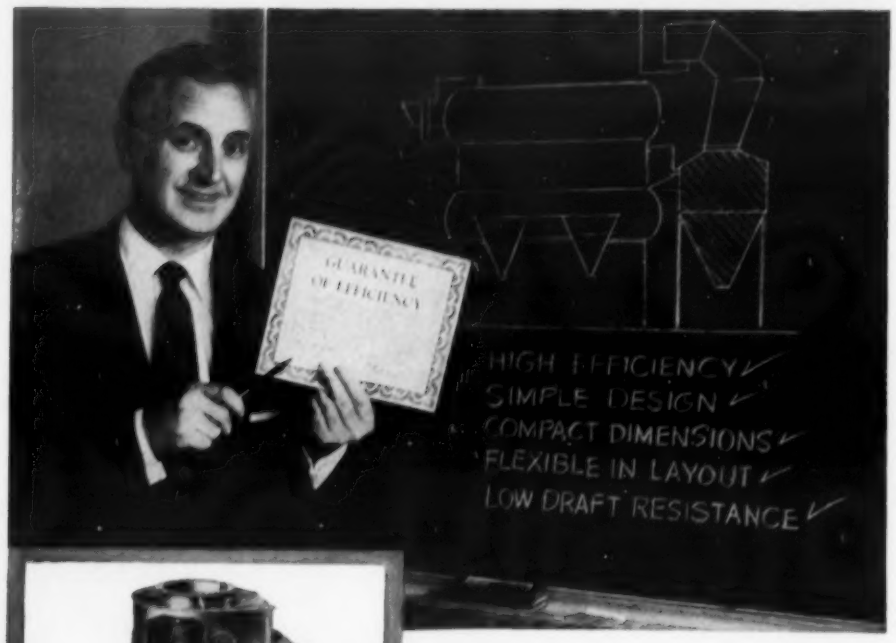

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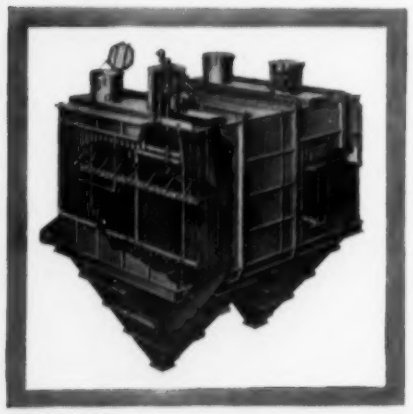

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Make pure water

. . . starts on page 14

Odor reducing methods that have been successful are:

- Removal of odor producing solids as soon as possible from aeration and biological oxidation processes
- Intensive and adequate oxidation of organic matter with sufficient air
- Maintaining an optimum oxidizing environment in the aeration tanks with proper pH and potent oxidizing organisms
- Addition of odor-suppressing chemicals
- Control of odor-producing vapors by fine water spraying
- Change of chemicals used in the neutralization of spent broth
- Application of oxidizing chemicals such as chlorine and hyperchlorite
- Evaporation of spent broth
- Proper and complete digestion of solids
- Complete combustion of sludge gas
- Control of solids concentration, pH and temperature

Other odor control methods are still under study or experimentation.

routine maintenance is the answer

Waste treatment system is under the supervision and management of the Engineering Maintenance Department. Operation is handled by the waste treatment operator and mechanical operators. All mechanical, electric, piping, painting and building maintenance is performed by the respective shop personnel. They are assigned on a routine schedule basis or on request through an approved job order. General housekeeping and ground maintenance is under the supervision of the Service Department.

Difficulties created by irregular hydraulic loadings are being solved by cooperation between production departments and waste treatment plant. By such cooperation, waste treatment plant operators are able to regulate treatment units on short notice to receive any high hydraulic load that may occur.

Satisfactory final effluent has been produced by this treatment system. Treatment cost is high in comparison with ordinary sewage treatment, however. It costs almost 30 cents to treat 1000 gallons of antibiotics waste whereas it costs only 5 to 10 cents to treat 1000 gallons of municipal sewage.

As in any industry, cost of treating wastes is governed by the materials that constitute the waste and also by the required degree of treatment and efficiency. Treatment cost for a large volume of strong wastes treated at a high efficiency is understandably high. Engineers at Eli Lilly are constantly striving to reduce the cost. ♦ ♦

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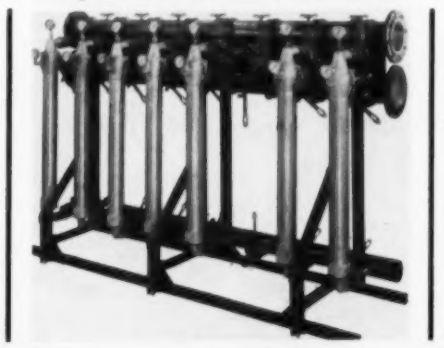

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How big a motor

. . . starts on page 16

gal pump starting speed-torque requirements. Proportions of this curve also vary with specific speed, and a speed-torque curve should be plotted when there is doubt as to driver's ability to produce excess accelerating torque at any percent of speed. Failure to produce torque excess will cause the driver to hang up and fail to accelerate to full speed. This condition can be very dangerous since it can cause overheating and extensive motor damage.

This same speed-torque curve can be shown with two typical motor speed-torque curves added (Fig. 2). Solid curve shows adequate margin between torque available and torque required for acceleration under any speed condition. Dotted motor speed-torque curve, on the other hand, crosses pump speed-torque curve at about 70% speed. No excess torque is available to accelerate the unit. Motor would hang-up and failure would occur under these conditions. In this case, failure would happen only if the pump were started along curve A-B-C. If such a condition occurs with existing equipment, a possible solution might be to insure that the pump is always started against a pressurized system or a closed discharge valve. In this way, there may be no intersection between the motor speed-torque curve and the pump speed-torque curve. Excess torque then is available under all conditions to provide adequate acceleration.

Let us see how we determine the acceleration rate of a pump-motor set knowing the speed-torque characteristics of motor and pump. Assume that we know the inertia WK^2 of each component.

The following formula applies:

$$T = \frac{(WK^2)\ (\Delta N)}{(307.6)\ (\Delta t)}$$

Where

T = available torque in foot-pounds
ΔN = change in rpm
Δt = elapsed time in minutes
WK^2 = inertia, measured in pound-feet, squared (obtained from pump and motor manufacturers).

In this formula, the WK^2 must, of course, be the total for all components. These include pump and driver with any secondary driving equipment such as a speed increasing gear or variable-speed drive. Using this formula and knowing the maximum allowable starting time for the motor, the adequacy of the excess accelerating torque available can be determined. This is done by calculating the actual time it would take the pumping set to go from zero speed to full speed. For accuracy, small increments of speed change should be computed individually. The sum of these should be added to produce the total elapsed time.

For example, using the solid motor-torque curve (Fig. 2), let us select first as an increment the range of 30% to 40% speed. Factor ΔN is equal to the actual value of 40% speed minus 30% speed for the particular pumping set involved. Applicable value of WK^2 is the sum of the individual WK^2 values obtained from the manufacturer of each piece of equipment.

T is computed for the particular increment we have selected (range of 30% to 40% speed) as follows: Available torque for acceleration at 30% speed is the motor-torque available less the pump torque required. That is, 100% minus 9% = 91%. Available torque for acceleration is calculated for 40% speed in the same fashion. The average of these two values is used as the T in the formula.

Using these terms in the above formula, Δt is calculated for the 30% to 40% increment. Then other speed change increments are taken to cover the entire speed range from 0 to 100%. The Δt values thus obtained are added together to arrive at the *total time* required to bring the pumping set from zero to full speed. This value is then compared with the motor manufacturer's maximum allowable time to determine the adequacy of the motor starting torque.

be sure your driving motor is adequate

Rated horsepower and speed data for a pump are insufficient knowledge to specify a driver correctly. The user also must know the torque characteristics of both pump and driver and the horsepowers to be encountered under all anticipated pump load conditions. With these data he can be sure that the driver is adequate to meet all load conditions. ♦ ♦

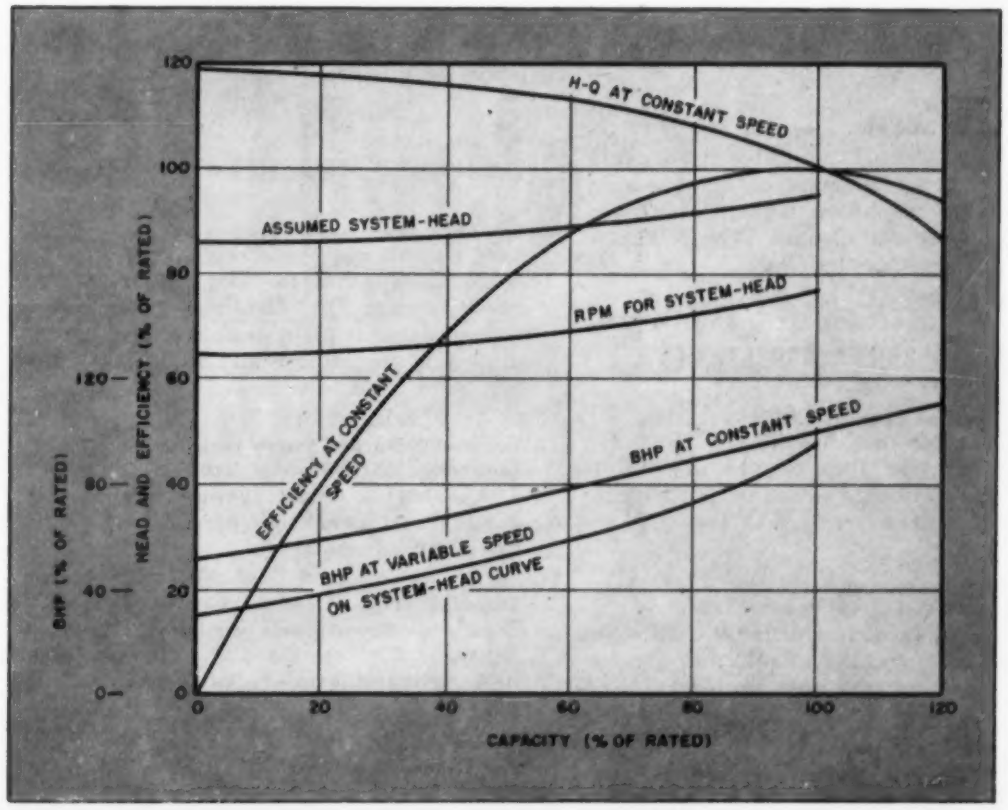
H-Q AT CONSTANT SPEED
ASSUMED SYSTEM-HEAD
RPM FOR SYSTEM-HEAD
EFFICIENCY AT CONSTANT SPEED
BHP AT CONSTANT SPEED
BHP AT VARIABLE SPEED ON SYSTEM-HEAD CURVE
BHP (% OF RATED)
HEAD AND EFFICIENCY (% OF RATED)
CAPACITY (% OF RATED)

Fig. 1 — Performance curve gives speed-power variations for a variable-speed centrifugal pump. Driving motor must match the pump load conditions shown.

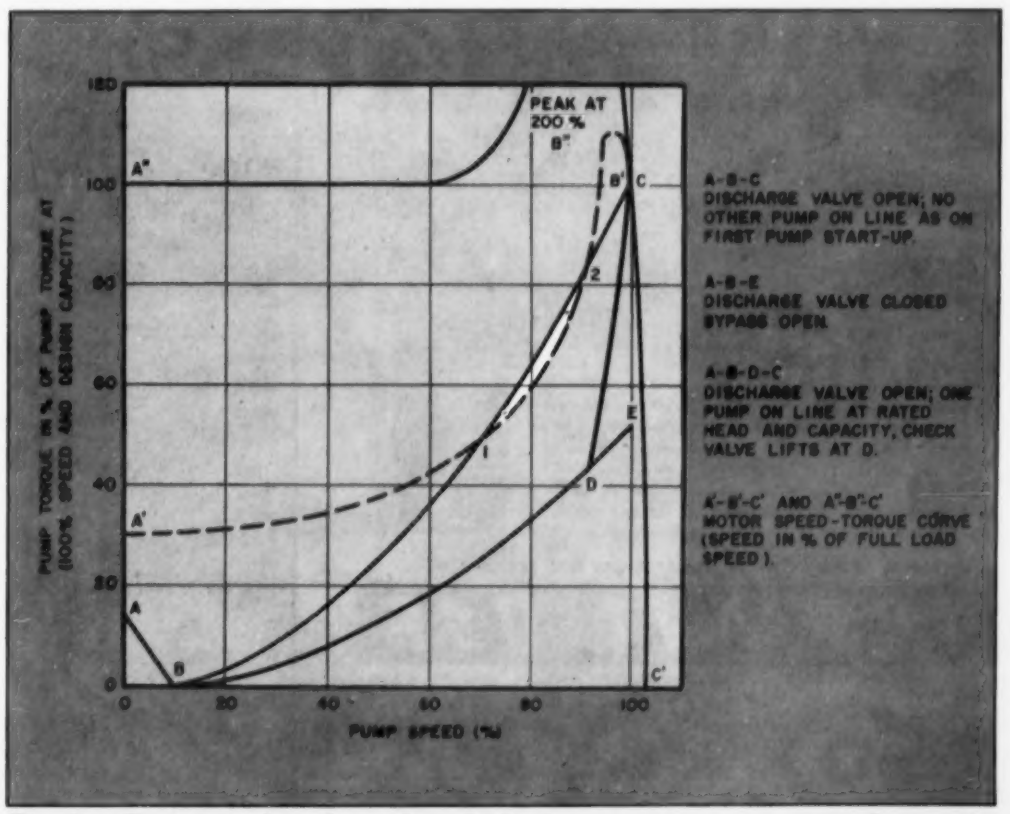
PEAK AT 200 % B"
A-B-C
DISCHARGE VALVE OPEN; NO OTHER PUMP ON LINE AS ON FIRST PUMP START-UP.
A-B-E
DISCHARGE VALVE CLOSED BYPASS OPEN.
A-B-D-C
DISCHARGE VALVE OPEN; ONE PUMP ON LINE AT RATED HEAD AND CAPACITY, CHECK VALVE LIFTS AT D.
A'-B'-C' AND A"-B"-C'
MOTOR SPEED-TORQUE CURVE (SPEED IN % OF FULL LOAD SPEED).
PUMP TORQUE IN % OF PUMP TORQUE AT (100% SPEED AND DESIGN CAPACITY)
PUMP SPEED (%)

Fig. 2 — Curve overlap shows how lack of excess torque can cause damage to motor. Starting the pump against back pressure can prevent this damage.

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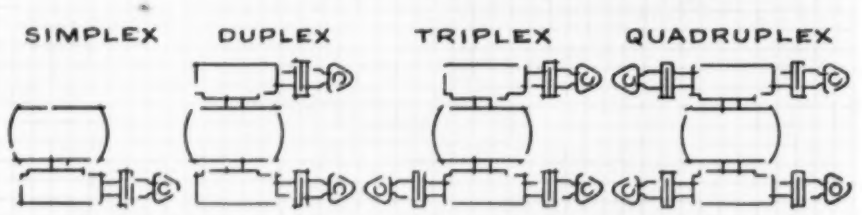

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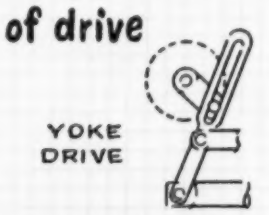

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handy guide

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May issue of INDUSTRY POWER

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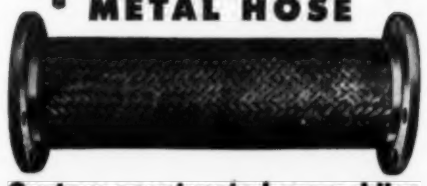

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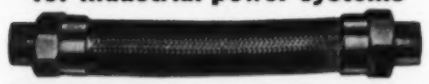

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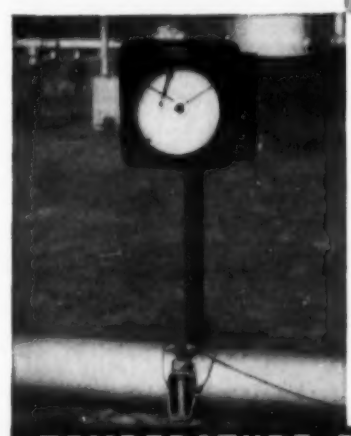

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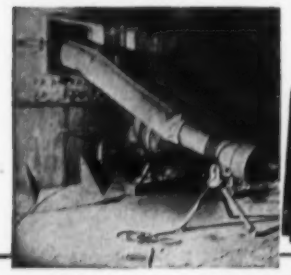

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Apr. 9-11	American Welding Society Fifth Welding Show	Convention Hall, Philadelphia
Apr. 14-17	Building Research Institute Annual Meeting	Drake Hotel, Chicago
Apr. 14-24	First U. S. World Trade Fair	Coliseum, New York City
Apr. 15-17	ASLE Meeting	Sheraton-Cadillac Hotel, Detroit
Apr. 22-24	ASME Instruments and Regulators Conference	Evanston, Ill.
Apr. 29-May 3	Seventh National Materials Handling Conference, Exposition	Convention Hall, Philadelphia
May 12-17	American Water Works Association Annual Convention	Atlantic City, N. J.
May 13-15	Purdue Industrial Waste Conference	Purdue University, Lafayette, Ind.
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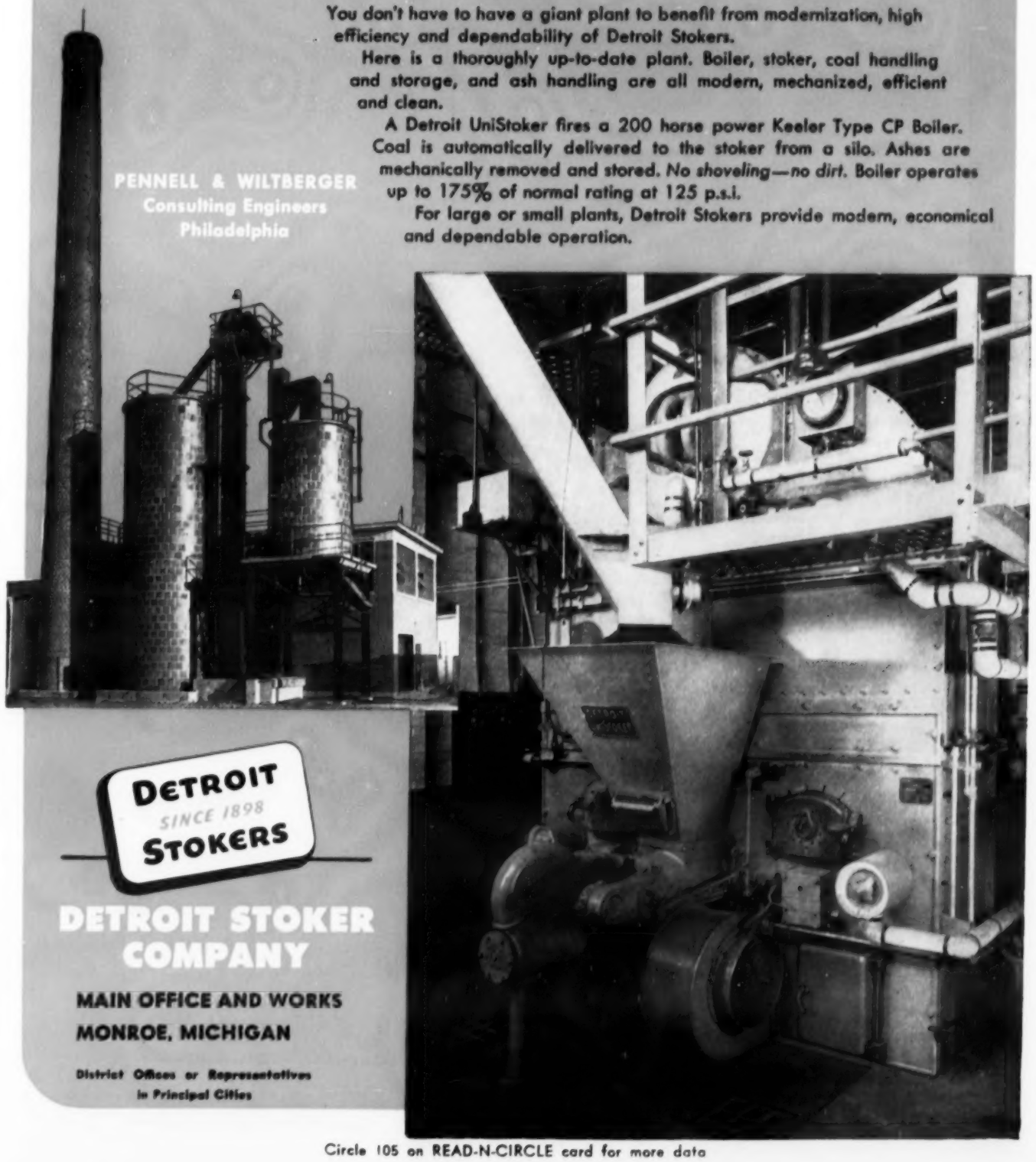

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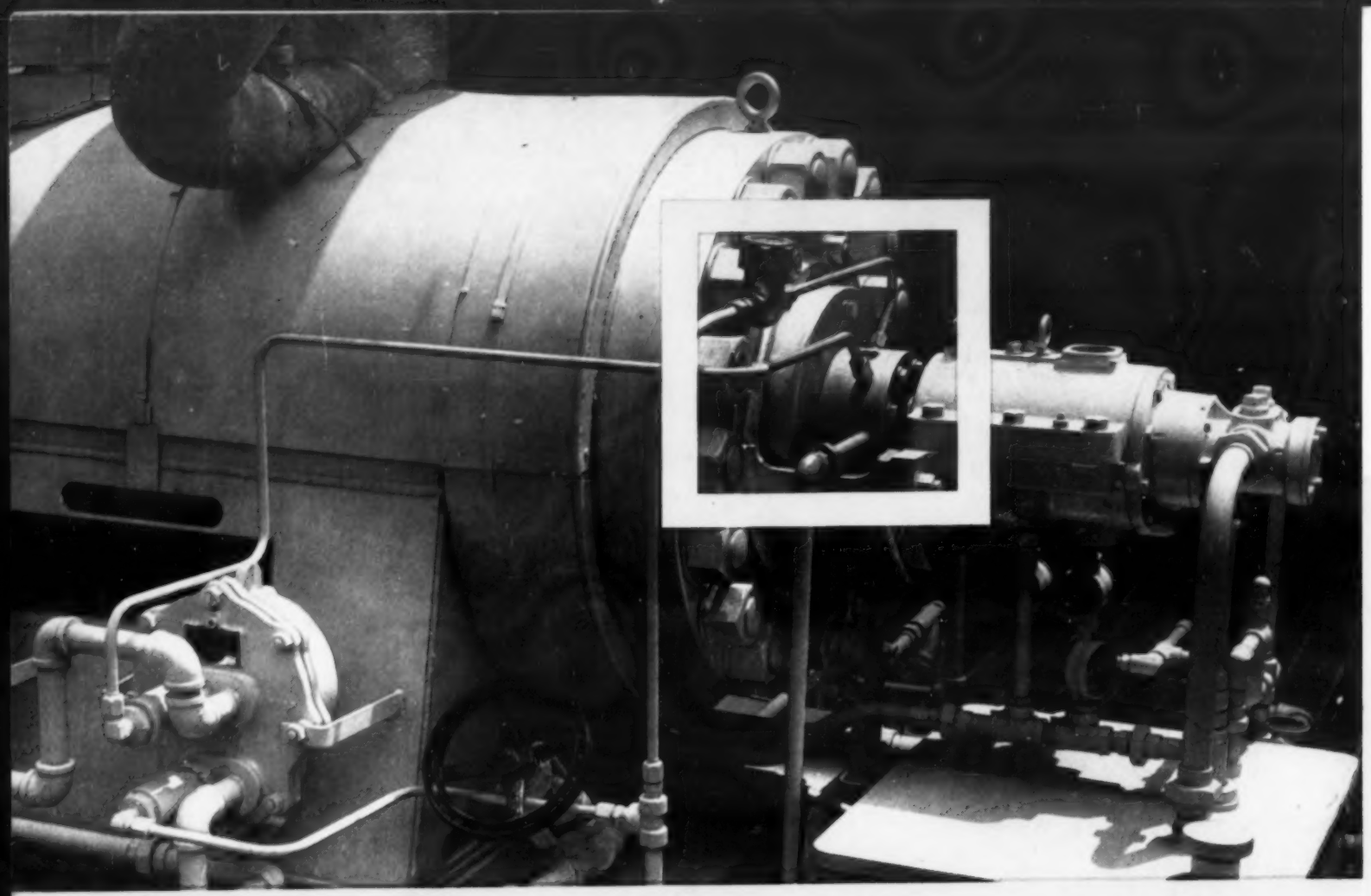

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